IMPROVING THE QUALITY OF WHEAT

BY

T. L. LYON

Thesis presented to the University Faculty of Cornell University for the Degree of Doctor of Philosophy

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PREFACE.

I wish to express my appreciation of the guidance of Professor I. P. Roberts, Professor G. C. Caldwell and Professor Thomas F. Hunt, who constituted the committee having my work in charge, also of the advice given by Dean L. H. Bailey and the assistance of Mr. G. N. Lauman. For the analytical work, extending through a period of seven years and involving several thousand chemical determinations, I am indebted to Professor S. Avery, Mr. R. S. Hiltner, Professor R. W. Thacher, Mr. Y. Nikaido, Miss Rachael Corr, Mr. H. B. Slade and Mr. G. H. Walker. Mr. Alvin Keyser has kept records of the wheat breeding plats and Mr. E. G. Montgomery has assisted in keeping other records.

CONTENTS.

TABLES OF EXPERIMENTS.

IMPROVING THE QUALITY OF WHEAT.

OBJECT OF THE INVESTIGATION.

Efforts to improve the wheat plant have been numerous and have accomplished important results. The work of Fultz, Clawson, Rudy, Wellman, Powers, Hayne, Bolton, Cobb, Green, and Hays in improving by selection, and of Pringle, Blount, Schindel, Saunders, Farrar, Jones, Carleton, and Hays in improving by hybridization, has resulted in giving this country many prolific strains and varieties of wheat, while Garton Brothers, of England, Farrar, of New South Wales, Vilmorin, of France, Rimpau, of Germany, and others have accomplished the same for other portions of the world. Attempts at improvement have, however, been directed primarily toward effecting an increase in the yield rather than in the quality of the crop. While the latter property has not been entirely lost sight of, selection based on quality has never been applied to the individual plant, but only to the progeny of otherwise desirable plants.

Why selection for quality of grain in the individual plant has not gone hand in hand with selection for other desirable properties is perhaps to be explained by the fact that no method for such selection has ever been devised. Mr. W. Farrar, of Queanbeyen, New South Wales, in an address made a short time ago, said:

> Before we can make any considerable progress in improving the quality of the grain of the wheat plant we shall have to devise a method for making a fairly correct quantitative estimate of the constituents * * * of the grain of a single plant and yet have seeds left to propagate from that plant.

In devising a method for increasing the percentage of nitrogen in wheat it becomes desirable to know the causes that produce variation in this constituent of the kernel. Numerous experiments and observations have been made on this subject, the results of which agree in the main in attributing such variation to the following conditions:

(1) Stage of development of the kernel.
(2) Variation in temperature of different regions.
(3) Variation in temperature of different years in the same region.
(4) Variation in the supply and form of soil nitrogen.
(5) Variation in the supply of soil moisture.

All of these factors have been studied, and are recognized as operative. Nothing, however, appears to have been done to show their influence upon the actual amount of nitrogen taken up by the wheat plant and deposited in the kernel. This is really the point of greatest interest; for although it is desirable to secure a wheat of greater nutritive value, it should not be done at the sacrifice of yield of nitrogenous substance.

Admitting that variation in the nitrogen content of wheat is induced by the conditions mentioned, it is essential to the plant breeder to know whether a high or low nitrogen content may be, under similar conditions, a characteristic of an individual plant; whether this quality is transmitted to the offspring; with what constant characteristics it is correlated, and whether a high percentage of nitrogen in a normal, perfectly matured wheat plant is an indication of a large accumulation of nitrogen by that plant.

The data contained in this paper cover the points mentioned, and it is hoped that some definite information has been gained that will lead to a practical solution of the problem of improving by breeding the quality of wheat for bread making.

PART I.

HISTORICAL.

SOME CONDITIONS AFFECTING THE COMPOSITION AND YIELD OF WHEAT.

Experiments to ascertain the effect of different conditions upon the composition and yield of wheat have been conducted mainly along the following lines:

(1) Stage of growth at which the grain is harvested.
(2) Influence of immature seed upon the resulting crop.
(3) Effect of climate.
(4) Effect of soil.
(5) Effect of soil moisture.
(6) Influence of size or weight of seed upon the resulting crop.
(7) Influence of specific gravity of seed upon the resulting crop.

A brief summary of a number of these experiments is herewith given.

COMPOSITION AS AFFECTED BY TIME OF CUTTING.

In 1879,[a] and again in 1892,[b] Dr. R. C. Kedzie conducted very careful experiments to note the chemical changes that occur in the wheat kernel during its formation and ripening. These agree in the main in showing a gradual decrease in the percentage of total nitrogen, albuminoid nitrogen, and non-albuminoid nitrogen from the time the grain set to the time the kernel was ripe. The decrease in all of these constituents was much more rapid during the first than during the last stages of this development. The percentage of ash decreased at the same time.

In 1897 Prof. G. L. Teller[c] carried on some experiments in which he covered the ground already gone over by Doctor Kedzie and also contributed to the knowledge of the subject some very important data concerning the proportion of the various proteids contained in the wheat kernel during the process of development. Teller found that the proportion of total nitrogen in the dry matter steadily decreased from the time the kernel was formed up to about a week before ripening, but that, unlike Doctor Kedzie's results, it gradually increased from that time on. He intimates that this increase before ripening may have been due to defective sampling and hoped to

[a] Report of Michigan Board of Agriculture, 1881–82, pp. 233–239.
[b] Michigan Agricultural Experiment Station Bulletin 101.
[c] Arkansas Agricultural Experiment Station Bulletin 53.

repeat the experiment to remedy this, but he has published nothing further. The amid nitrogen continued to decrease up to the time of ripening, as did also the ash, fats, fiber, dextrins, and pentosans. There was a gradual and marked increase in the proportion of gliadin up to the time of ripening, and a somewhat less and rather irregular decrease in the proportion of glutenin during the same period.

Failyer and Willard[a] report analyses of wheat in the soft-dough stage and when ripe. The ash, crude fiber, fat, and the total and albuminoid nitrogen were higher in the soft-dough wheat, and the nitrogen-free extract and non-albuminoid nitrogen were higher in the ripe wheat.

Dietrich and König[b] quote results from five experimenters—Reiset, Stockhardt, Heinrich, Nowacki, and Handtke. Only in one case (Heinrich) is there a constant decrease in total nitrogen as the grain approaches ripeness. There is much inconstancy in the results, there being in some cases a decrease in nitrogen between the milk stage and full ripeness and sometimes an increase. There is little information to be gained from the results quoted by Dietrich and König.

Körnicke and Werner in their "Handbuch des Getreidebaues"[c] refer to the work of Stockhardt, and also that of Heinrich, to show that during the process of ripening the percentage of nitrogen in the wheat kernel gradually diminishes, as does also the percentage of ash, and that, on the other hand, the percentage of carbohydrates increases during the same period. Heinrich also shows by a statement of the number of grams of these constituents in 2,600 kernels at different stages of development that the absolute amount of nitrogen and ash increases up to the time of ripening, and that consequently the decrease in the percentage of these constituents is due to the rapid increase in the carbohydrates. The results obtained by Heinrich appear as follows when tabulated:

Stage of growth.	Starch.		Protein.		Ash.	
	Percentage in 100 parts of dry matter of kernel.	Grams in 2,600 kernels.	Percentage in 100 parts of dry matter of kernel.	Grams in 2,600 kernels.	Percentage in 100 parts of dry matter of kernel.	Grams in 2,600 kernels.
14 days after bloom	61.44	22.0	14.05	5.0	2.48	0.84
Beginning to ripen	74.17	58.5	12.21	10.0	2.14	1.70
Ripe	75.66	67.0	11.82	10.5	1.97	1.75
Overripe	76.38	70.0	11.67	10.7	1.88	1.79

Nedokutschajew[d] analyzed wheat kernels at different stages of development and found an almost uniform decrease in the percentage

[a] Kansas Agricultural Experiment Station Bulletin 32.

[b] Zusammensetzung u. Verdaulichkeit der Futtermittel, 1, p. 419.

[c] Handbuch des Getreidebaues, Berlin, 1884, 2, pp. 474–476.

[d] Landw. Vers. Stat., 56 (1902), pp. 303–310.

of total nitrogen, a slight but irregular decrease in the percentage of proteid nitrogen in the dry matter, and a constant decrease in the percentage of amid nitrogen. He holds that the amid substances are converted into albumen as the kernels ripen. His figures are as follows:

Date.	Weight of kernel (mg.).	Percentage of—				
		Dry matter.	Total nitrogen.	Proteid nitrogen.	Asparagin nitrogen.	Amid nitrogen.
July 13	9.17	30.14	2.87	1.90	0.29	0.68
July 18	15.80	37.23	2.55	1.94	.20	.41
July 24	30.79	45.18	2.65	2.33	.19	.13
July 29	37.99	38.37	2.46	2.08	.16	.22
August 3	46.39	51.52	2.32	1.98	.13	.21
August 9	45.46	49.83	2.37	2.13	.11	.13

Judging from these results there can be no doubt that the percentage of nitrogen, both total and proteid, decreases as the kernel develops, owing to the more rapid deposition of starch that goes on during the later stages of growth. The larger part of the nitrogen used by the wheat plant appears to be absorbed during the early life of the plant. This is transferred in large amounts to the kernel in the early stages of its development, after which nitrogen accretion by the kernel is comparatively slight. The deposition of starch, on the other hand, continues actively during the entire development of the kernel. It would further appear that the amid nitrogen is converted into proteid compounds as development proceeds.

As showing the stages of growth of the wheat plant at which the greatest absorption of nitrogen occurs, some experiments may be quoted.

Lawes and Gilbert [a] say:

> In 1884 we took samples of a growing wheat crop at different stages of its progress, commencing on June 21, and determind the dry matter, ash, and nitrogen in them. Calculation of the results showed that, while during little more than five weeks from June 21 there was comparatively little increase in the amount of nitrogen accumulated over a given area, more than half the total carbon of the crop was accumulated during that period.

Snyder's analyses [b] show that of the total amount of nitrogen taken up by the wheat plant, 85.97 per cent is removed from the soil within fifty days after coming up, 88.6 per cent by time of heading out, and 95.4 per cent by the time the kernels are in the milk.

Adorjan [c] finds that assimilation of plant food from the soil is not proportional to the formation of dry matter in the plant, but that it proceeds more rapidly in the early stages of growth. During early growth nitrogen is the principal requirement. The nitrogen stored

[a] On the Composition of the Ash of Wheat Grain and Wheat Straw, London, 1884.

[b] Minnesota Experiment Station Bulletin 29, pp. 152–160.

[c] Abstract, Experiment Station Record, 14, p. 436, from Jour. Landw., 50 (1902), pp. 193–230.

up at that time is, he says, used later for the development of the grain.

It is too well known to require substantiation by experimental evidence that the yield of grain per acre and the weight of the individual kernel increase as the grain approaches ripeness. It is therefore quite evident that immaturity, although resulting in a higher percentage of nitrogen in the wheat kernel, would curtail the production of nitrogen by the crop, and, furthermore, that the production of proteids would be still further lessened by reason of the greater proportion of amid substances present in the grain at that time.

INFLUENCE OF IMMATURE SEED UPON YIELD.

Georgeson[a] selected kernels from wheat plants that were fully ripe, and from plants cut while the grain was in the milk. He seeded these at the same rate on 2 one-tenth acre plots of land. The immature seed yielded at the rate of 19.75 bushels per acre of grain and 0.8 ton of straw, while the mature seed produced 22 bushels of grain and 1.04 tons of straw per acre. Georgeson says that in a similar experiment the previous year the difference in favor of the mature seed was still more pronounced.

Although the evidence is limited, it may safely be considered that the use of immature seed will result in a smaller yield of wheat than if fully ripe seed be used.

INFLUENCE OF CLIMATE UPON COMPOSITION AND YIELD.

Lawes and Gilbert[b] state that "high maturation in the wheat crop as indicated by the proportion of dressed corn in total corn, proportion of corn in total product (grain and straw), and heavy weight of grain per bushel, is, other things being equal, generally associated with a high percentage of dry substance and a low percentage of both mineral and nitrogenous constituents." This is based upon the wheat crops at Rothamsted for the years 1845 to 1854, inclusive.

More recent publications[c] by these investigators reaffirm their belief that the composition of the wheat kernel depends more largely upon the conditions that affect its degree of development than upon any other factor. They found almost invariably that a season that favored a long and continuous growth of the plant after heading, resulting in a large yield of grain, a high weight per bushel, and a plump kernel, produced a kernel of low nitrogen content.

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[a] Abstract, Experiment Station Record, 4, p. 407, from Kansas Experiment Station Bulletin 33, p. 50.

[b] On Some Points in the Composition of Wheat Grain, London, 1857.

[c] Our Climate and Our Wheat Crops, London, 1880, and On the Composition of the Ash of Wheat Grain and Wheat Straw, London, 1884.

Körnicke and Werner[a] cite an experiment in which winter wheat grown in Poppelsdorf for several years was sent to and grown in the moist climate of Great Britain, in Germany, and in the continental climate of Russia (steppes). The results were as follows:

Locality.	Number of experiments.	Weight (in grams) of—		Percentage of—	
		100 plants.	Kernels from 100 plants.	Grain.	Straw.
Great Britain	37	600	227	37.8	62.3
Germany	18	500	204	40.8	59.2
Southern Russia	19	365	160	44.0	56.0

These investigators conclude from the results that in a moist climate relatively more straw and less grain are produced than in a dry, warm climate. The thickness of the straw and the weight of the kernels from 100 heads are greater, while the percentage by weight of kernels to straw is much less in a moist climate. They also quote Haberlandt as saying that a continental climate produces a small, hard wheat kernel, rich in gluten and of especially heavy weight.

Dehérain and Dupont[b] report some interesting observations as to the effect of climate on the composition of wheat. They state that the harvest of 1888 at Grignon was late and the process of ripening slow. There was a heavy yield of grain having a gluten content of 12.60 per cent and a starch content of 77.2 per cent. The following season was dry and hot, with a rapid ripening of the grain, resulting in a smaller crop. The gluten content of the grain was 15.3 per cent and the starch content 61.9 per cent. They removed the heads from a number of plants. The next day the stems were harvested, as were also an equal number of entire plants. The stems without heads showed that carbohydrates equal to 5.94 per cent of the dry matter had been formed. The stems on which the heads remained one day longer contained 1.63 per cent carbohydrates. They argue from this that the upper portion of the stem, provided it is still green, performs the functions of the leaves in other plants and thus elaborates the starch that fills out the kernel in its later development.

A report from the Ploti Experiment Station[c] states that the conditions that favored an increase in yield caused a reduction in the relative proportion of nitrogen in the grain. Excessive humidity favored the process of assimilation of carbohydrates, while drought hastened maturation and produced a grain relatively rich in proteids.

[a] Handbuch des Getreidebaues, Berlin, 1884, pp. 69, 70.

[b] Ann. Agron., 1902, p. 522.

[c] Abstract, Experiment Station Record, 14, p. 340, from Sept. Rap An. Sta. Expt. Agron. Ploty, 1901, pp. xiv–180.

Wiley[a] sent wheat of the same origin to California, Kentucky, Maryland, and Missouri. The original grain and the product from each State were analyzed. The results of one year's test were reported. Regarding the effect of climate, he says:

There appears to be a marked relation between the content of protein matter and starch and the length of the growing season. The shorter the period of growth and the cooler the climate the larger the content of protein and the smaller the content of starch, and vice versa.

Shindler,[b] in his book upon this subject, says (p. 75):

With the length of the growing period, especially with the length of the interval between bloom and ripeness, varies not only the size of the kernel, but also the relative amount of carbohydrates and protein it contains.

Again, on page 76, Shindler says:

All this shows that the protein constituent of the kernel depends in the first place upon the length of the growing period and next upon the richness of the soil.

Melikov[c] made analyses of different varieties of wheat of the crops of the years 1885–1899 grown in southern Russia. The protein varied in different years from 14 to 21.2 per cent. Melikov concludes that the nitrogen content is highest in dry years and lowest in years of larger rainfall, in which years the yield of wheat per acre is also greater.

Gurney and Morris,[d] in one of their reports, say:

This increased gluten [over previous years] is probably largely due to differences in the seasons, the weather being hot and dry while the grain was ripening, since it is characteristic not of these wheats alone but of most of the grain grown in the colony.

The conclusion to be inevitably derived from these observations is that climate is a potent factor in determining the yield and composition of the wheat crop, and, further, that its effect is produced by lengthening or shortening the growing season, particularly that portion of it during which the kernel is developing. A moderately cool season, with a liberal supply of moisture, has the effect of prolonging the period during which the kernel is developing, thus favoring its filling out with starch, the deposition of which is much greater at that time than is that of nitrogenous material. With this goes an increase in volume weight and an increased yield of grain per acre. On the other hand, a hot, dry season shortens the period of kernel development, curtails the deposition of starch, leaving the per-

[a] Yearbook U. S. Department of Agriculture, 1901, pp. 299–308.

[b] Der Weizen in seinem Beziehungen zum Klima und das Gesetz der Korrelation, Berlin, 1893.

[c] Abstract, Experiment Station Record, 13, p. 451, from Zhur. Opuitn. Agron., 1 (1900), pp. 256–267.

[d] Agricultural Gazette of New South Wales, 12, pt. 2, pp. 1403–1424.

centage of nitrogen relatively higher, and gives a grain of lighter weight per bushel and smaller yield per acre.

The fact that one variety of wheat is adapted to a hot, dry climate and another to a cool, moist one does not mean that the former undergoes as complete maturation as the latter, even though the grain is not shriveled. This is shown by the fact that a variety of wheat well adapted to a hot, dry climate will, when planted in a cool, moist one, immediately grow plumper and the kernel weight will increase, as was the case in the experiment of taking Minnesota wheats to Maine.

INFLUENCE OF SOIL UPON COMPOSITION AND YIELD.

In considering the effect of the soil upon the wheat crop there will naturally be included experiments designed to show the effect of fertilizers upon the crops. It is, in fact, upon experiments with fertilizers that we must depend for most of our information on this subject.

Experiments to ascertain the effect of fertilizers upon the composition of the wheat kernel were conducted by Lawes and Gilbert for a period of years extending from 1845 to 1854.[a] Plots of land in which wheat was grown continually were treated annually as follows: Unmanured, manured with ammoniacal fertilizer alone, and manured with ammoniacal fertilizer and proportionate amounts of mineral salts. In composition calculated to dry matter, the wheat on the plots receiving ammoniacal fertilizer alone contained quite uniformly a slightly larger amount of nitrogen than either of the other two. The averages for the ten years were as follows:

Kind of fertilizer, if any.	Percentage of—		Weight of grain per bushel (pounds).	Percentage of good kernels.	Yield per acre (pounds).
	Nitrogen in dry matter.	Ash in dry matter.			
Unmanured	2.13	2.07	58.51	90.6	1,045
Ammonium salts	2.26	1.85	58.9	90.3	1,668
Minerals and ammonium salts	2.22	1.96	60.2	92.8	1,969

There was practically no difference in the nitrogen content of the straw. From these experiments the authors quoted conclude that there is no evidence that the nitrogen content of the wheat kernel can be increased at pleasure by the use of nitrogenous manures.

Ritthausen and Pott[b] report an experiment in which plots of land were manured (1) with superphosphate alone, (2) with nitrate alone, (3) with a mixture of superphosphate and nitrate, and (4) were left

[a] On Some Points in the Composition of Wheat Grain, London, 1857.

[b] Landw. Vers. Stat., 16 (1873), pp. 384–399.

unmanured. There were three plots of each. The following is a tabulated statement of their results:

Kind of fertilizer, if any.	Weight of 52 c. c. of kernels (grams).	Yield of grain on plot (kilos).	Percentage of nitrogen in dry matter.
Unfertilized	1,306	....	2.60
Superphosphate	1,339	2.72	3.49
Nitrate	1,413	2.30	3.43
Superphosphate and nitrate	1,451	2.03	3.62

It will be noticed that the effect of the nitrate fertilizer was to decrease the yield of grain, but to increase the size of the kernel and its content of nitrogen.

Wolff,[a] as early as 1856, in summing up the experiments of Hermbstadt, Muller, and John with barley, and of Lawes and Gilbert with wheat, says:

In the presence of a sufficient amount of phosphoric acid and alkali the effect of manuring with an easily soluble nitrogen compound is an improvement in the grain both in quantity and quality [meaning plumper kernels]. The kernels decrease in percentage of nitrogen, but become plumper, become absolutely and relatively richer in starch, and have a better appearance and a higher commercial value. But when the nitrogenous food in the soil exceeds a certain relation to the temperature and rainfall the quality of the grain becomes poorer [harder], it becomes lighter and smaller, takes on a darker color, and generally becomes richer in percentage of nitrogen in the air-dry substance.

Von Gohren[b] also reports results of experiments in fertilizing wheat. All experiments were apparently made in the same year. He grew the crop on six different plots of land, five of which were manured and each with a different fertilizer. In the crop he distinguished between large kernels and small kernels to show the quality of the product. Determinations of proteids and starch were made, and these were calculated to the yield of each constituent on each plot.

The following table shows the yield of each of the characters determined, and compares those raised on the unmanured plot with those on the manured ones by taking the former as one and reducing the others to the corresponding figure:

Yield and percentage.	Unfertilized.	Ashes.	Oil cake.	Bat guano.	Oil cake and ashes.	Peruvian guano.
Yield of grain	1.000	1.011	1.071	1.143	1.215	1.286
Yield of large kernels	1.000	.146	1.928	2.552	2.226	2.786
Yield of small kernels	1.000	.953	.704	.538	.781	.642
Yield of proteids	1.000	.999	.915	.936	1.070	1.114
Yield of starch	1.000	1.009	1.081	1.174	1.264	1.303
Percentage of proteids	14.42	14.25	12.70	11.81	12.70	13.22
Percentage of starch	62.67	62.56	63.25	64.41	65.24	63.55

The results show an increased yield from the use of fertilizers, the production increasing with the application of complete manures.

[a] Die naturgesetzlichen Grundlagen des Ackerbaues, Leipzig, 1856, p. 774.

[b] Landw. Vers. Stat., 6 (1864), pp. 15–19.

The yield of grain of good quality increases in the same way, and the yield of grain of poor quality decreases proportionately. It must be remembered that by good quality of grain in these early writings is meant plump kernels and not necessarily what would be considered wheat of good milling quality at the present day. The production of proteids per acre decreased with the use of the incomplete fertilizers, ashes and oil cake, and even with the bat guano. It increased, however, with the use of oil cake and ashes combined and of Peruvian guano. The percentage of proteids was greatest in the unfertilized grain and the percentage of starch least, with the exception of one fertilized plot.

The very evident effect of the fertilizers in this case was to produce a more completely matured kernel. It will be noticed that the plots producing grain of highest starch content were those having the greatest proportion of plump kernels.

Again, in 1884, Lawes and Gilbert[a] report results obtained from manured and unmanured soils. These experiments cover a period of sixteen years and are divided into two periods of eight years each. In one of these periods the seasons were favorable for wheat, in the other unfavorable.

Character.	Favorable seasons.			Unfavorable seasons.		
	Barnyard manure.	Unmanured.	Ammonium salts alone.	Barnyard manure.	Unmanured.	Ammonium salts alone.
Weight of grain per bushel (pounds)	62.6	60.5	60.4	57.4	54.3	53.7
Percentage of grain to straw	62.5	67.4	66.2	54.5	51.1	46.7
Grain per acre (pounds)	2,342.0	1,156.0	1,967.0	1,967.0	823.0	1,147.0
Straw per acre (pounds)	6,089.0	2,872.0	4,774.0	5,574.0	2,433.0	3,601.0
Percentage of nitrogen in dry matter	1.73	1.84	2.09	1.96	1.98	2.25
Percentage of ash in dry matter	1.98	1.96	1.74	2.06	2.08	1.91
Nitrogen per bushel (pounds)	1.083	1.113	1.262	1.125	1.075	1.208

It is evident from this statement that the largest crops and best developed kernels were obtained from the soils treated with barnyard manure, and that these kernels contained the lowest percentage of nitrogen. The crops on unmanured soil stood next in these respects, except in yield. Those on the soil receiving ammonium salts produced the most poorly developed kernels and those of highest nitrogen content, but gave larger yields than the unmanured soil.

In the unmanured soil there was a very evident lack of plant food, as indicated by the light crops. The effect upon the kernel was to curtail its development, leaving it of light weight and with a relatively high nitrogen content.

[a] On the Composition of the Ash of Wheat Grain and Wheat Straw, London, 1884.

Hermbstadt obtained some curious results, as quoted by D. G. F. MacDonald,[a] as follows:

He sowed equal quantities of wheat upon the same ground and manured them with equal weights of the different manures set forth below. From 100 parts of each sample of grain produced he obtained starch and gluten in the following proportions:

Kind of fertilizer, if any.	Gluten.	Starch.	Produce.
Unfertilized	9.2	66.7	Threefold.
Potato peels	9.6	65.94	Fivefold.
Cow dung	12.0	62.3	Sevenfold.
Pigeon dung	12.2	63.2	Ninefold.
Horse dung	13.7	61.64	Tenfold.
Goat dung	32.9	42.4	Twelvefold.
Sheep dung	32.9	42.8	Do.
Dried night soil	33.14	41.44	Fourteenfold.
Dried ox blood	34.24	41.43	Do.
Dried human urine	31.1	39.3	Twelvefold.

These results are not to be considered seriously, representing as they do an impossible condition.

Prof. H. A. Huston[b] treated 0.01-acre plots of land each with nitrate of soda, dried blood, sulphate of ammonia, rotted stable manure, and muck, respectively, either in the autumn or spring, or in both seasons. In 1891 all the plots treated with nitrogenous compounds showed marked increase in the percentage of nitrogen in the grain. In 1892 the results were by no means so uniform and would not justify the conclusion that nitrogenous fertilizers increased the nitrogen content of the wheat.

Vignon and Conturier[c] tested the effect of phosphate fertilizer alone upon the nitrogen content of the grain of two varieties of wheat. On Plot 1 they used 75 kilograms of phosphoric acid per hectare; on Plot 2, 150 kilograms, and on Plot 3, 225 kilograms.

Variety.	Percentage of nitrogen in grain.		
	Plot 1.	Plot 2.	Plot 3.
Goldendrop	1.83	1.61	1.54
Riéte	2.07	1.98	1.82

There was a very evident decrease in the nitrogen content of the crop as the quantity of fertilizer was increased.

It was concluded from experiments conducted at the Ploti Experiment Station[d] that, with favorable meteorological conditions, manure increased the total amount of nitrogen taken up by wheat, but,

[a] Practical Hints on Farming, London, 1868.

[b] Indiana Experiment Station Bulletins 41 and 45.

[c] Compt. Rend., 132 (1901), p. 791.

[d] Abstract, Experiment Station Record, 14, p. 340, from Sept. Rap. An. Sta. Expt. Agron. Ploty, 1901, pp. xiv–180.

although it thus increased the total production of nitrogen, it decreased the relative proportion of nitrogenous substance.

Bogdau[a] conducted investigations the results of which indicated that with an increase in the soluble salt content of 22 alkali soils the nitrogen and ash contents of the wheat kernels increased, but the absolute weight of the kernels diminished. These soluble salts are rich in nitrates.

Experiments were conducted by Whitson, Wells, and Vivian[b] in which plants were grown in pots the soils of which were in some cases fertilized with nitrates and in others with leachings of single and of double strengths from fertile soils. Field experiments were conducted on manured and unmanured plots. All of the analyses, except in the case of oats, were of the whole plant. Of the ripe oat kernels those from the unfertilized soil contained 2.57 per cent of nitrogen, while the average of those from the fertilized soil was 2.78 per cent.

Guthrie[c] conducted experiments with fertilizers for wheat during two years, in which he kept a record of the yield and gluten content of the grain. The following is a statement of the results:

Kind of fertilizer, if any.	Experiments in 1901—				Experiments in 1902, at Wagga.	
	At Wagga.		At Bathurst.			
	Yield per acre (bushels).	Percentage of gluten.	Yield per acre (bushels).	Percentage of gluten.	Yield per acre (bushels).	Percentage of gluten.
None	7.7	11.99	13	11.80	17.6	9.8
Ammonium sulphate	8.7	10.43	16	11.21	17.6	8.7
Superphosphate	13.3	12.06	13.5	12.01	22.6	11.4
Potassium sulphate	13.0	12.02	13.0	11.29	19.2	10.0
Ammonium sulphate, superphosphate, potassium sulphate	10.0	11.70	13.7	12.05	20.3	12.0

In this experiment there was in each case a higher percentage of gluten in the wheat raised on the fertilized soil than in that from the soil fertilized with ammonium sulphate, and in the latter less than in the grain fertilized with other material.

The most striking feature of these results is their apparent lack of uniformity. In some cases the use of nitrogenous fertilizers was accompanied by an increase in the nitrogen content of the grain and in other cases no increase appeared; in some cases phosphoric acid fertilizers apparently increased the nitrogen content and in others they did not have this effect.

Climatic influences have doubtless operated largely in these results, but they are not considered by any of the experimenters except Wolff.

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[a] Abstract, Experiment Station Record, 13, p. 329, from Report of Department of Agriculture, St. Petersburg, 1900.

[b] Wisconsin Experiment Station Report, 19 (1902), pp. 192–209.

[c] Agricultural Gazette of New South Wales, 13 (1902), No. 6, p. 664; and No. 7, p. 728.

It is evident that in all experiments with depleted soils the plants on the plots receiving complete fertilizers would take up larger amounts of plant food, including nitrogen, than would plants on unmanured soils. Any conditions that would prevent the normal ripening of the crop on both soils would therefore leave a higher percentage of nitrogen in the plants upon the unmanured soil. On the other hand, under conditions which would permit of a complete maturation of the crop there might be no difference in the composition of the grain from the manured and unmanured soils. It is evident, however, that the production of both nitrogen and starch in pounds per acre would be greater on the manured soils.

Another condition that may affect the results is the arrested development of kernels on unmanured soils that are seriously depleted of plant food. Such depletion may interfere with complete maturation of the crop while the crop on the manured soil will mature fully. In consequence the grain on the unmanured soil will contain a higher percentage of nitrogen but a smaller yield per acre. The use of a nitrogenous manure alone on exhausted soils may likewise result in a grain of higher nitrogen content.

Expressed in a more general way, this means that wheat of the same variety grown under the same climatic conditions will have approximately the same percentage of nitrogen if allowed to mature fully, but any permanent interruption in the process of maturation will result in a higher percentage of nitrogen, and in the latter case the percentage of nitrogen will depend upon the stage at which development was interrupted, and also upon the amount of nitrogen accumulated by the plant, that being greater on soils manured with nitrogenous fertilizers alone than on exhausted soils, and greater on soils receiving complete manures than on exhausted soils receiving only nitrogenous fertilizers, provided the stage at which development ceased be the same in both cases. It thus happens that wheat growing on the soil allowing it to absorb the largest amount of nitrogen will, other things being equal, have a higher nitrogen content if the development of the kernel be permanently checked, although if it were allowed to mature fully it would not have a greater percentage of nitrogen than that grown on the soil affording less nitrogen.

Reviewing the experiments, we find that in Lawes and Gilbert's first experiment the percentage of nitrogen in the unmanured soil was less than on the soil receiving only nitrogenous fertilizer, and that the weight of grain per bushel and the percentage of good kernels on the two plots were practically the same. It would not appear, therefore, that the wheat on the plot receiving the nitrogenous fertilizer was less well matured than that on the unmanured plot. In this case there appears to be a slight increase in the percentage of nitrogen, due entirely to the use of nitrogenous fertilizers. Comparing the grain on

the plot receiving only nitrogenous fertilizer with that receiving the complete fertilizer it will be seen that the former has a higher percentage of nitrogen, but this is evidently due to the poorly developed kernels which weigh less per bushel than the grain on the completely fertilized plot.

Von Gohren's results show plainly that the kernels on the manured land developed better than on the unmanured, and with this better development there was an increase in the percentage of starch and a decrease in the nitrogen.

In Lawes and Gilbert's second experiment the percentage of nitrogen in the wheat on the soil manured with ammonium salts was less than that in the wheat on the unmanured soil, but the weight of grain per bushel shows that the higher nitrogen content was due, in part at least, to incomplete maturation. The higher percentage of nitrogen in the wheat on the soil receiving only nitrogenous manures as compared with that receiving complete manures can be traced to the same condition of the grain.

INFLUENCE OF SOIL MOISTURE UPON COMPOSITION AND YIELD.

Experiments were conducted by D. Prianishinkov[a] in which wheat was raised with different degrees of moisture, but in the same soil and under the same conditions of light and temperature. With a larger amount of moisture in the soil there was a lower nitrogen content in the grain. It was also stated that the duration of the period of vegetation was somewhat shorter when the moisture supply was greater.

Traphagen[b] reports marked changes in the composition of wheat grown with and without irrigation at the Montana Experiment Station. A wheat grown under irrigation on the station farm was planted the following year on land not irrigated. Presumably the land was of similar character. The two crops of grain were analyzed and the percentages stated below were found.

Crop.	Moisture.	Crude protein.	Ether extract.	Nitrogen-free extract.	Crude fiber.	Ash.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Irrigated wheat	7.87	8.81	1.93	76.99	2.60	1.80
Unirrigated wheat	7.65	14.41	2.23	71.33	2.65	1.70

No records of yields or of weights of kernels are given, but it is fair to suppose that the unirrigated wheat possessed the light, shrunken kernel which is characteristic of wheat raised without sufficient moisture.

[a] Abstract, Experiment Station Record, 13, p. 631, from Zhur. Opuitn. Agron., 1 (1900), No. 1, pp. 13–20.

[b] Montana Experiment Station Report (1902), pp. 59–60.

Irrigation experiments were conducted by Widtsoe[a] in which wheat of the same variety was raised on plots of land each one of which received a different quantity of water. A record was kept of the yield and composition of the grain on each plot.

Plot.	Water applied (inches).	Yield per acre (bushels).	Percentage of—		Yield (in pounds) per acre of—	
			Protein in grain.	Ash in grain.	Nitrogen.	Ash.
317	4.63	4.50	24.8	2.50	10.7	6.75
319	5.14	3.83	23.2	3.07	8.5	7.05
320	8.73	10.33	19.9	2.54	19.7	15.74
318	8.89	11.33	19.4	2.93	21.1	19.72
321	10.30	14.66	18.4	2.34	25.9	20.24
325	12.09	11.16	21.3	3.25	22.8	21.44
322	12.18	11.66	23.1	2.88	25.8	20.30
326	12.80	13.00	17.1	2.52	21.3	21.50
327	17.50	15.33	17.2	2.57	25.3	23.64
328	21.11	17.33	15.9	2.34	26.4	24.33
329	30.00	26.66	14.0	4.14	35.8	66.20
330	40.00	14.50	17.1	2.52	23.8	21.92

The results show that with an increase in the water used for irrigation up to 30 inches there were in general an increase in the yield of grain and a decrease in the nitrogen content. No volume weights or other means of judging of the development of the kernels on the different plots are given, but there is no reason to suppose that the grain on the plots receiving small quantities of water was not poorly developed. The column added showing the yield of nitrogen in pounds per acre indicates a lack of nutriment in the grain on these plots.[b]

High nitrogen content arising from a small supply of soil moisture is sometimes due to a restricted development of the kernel. There is nothing in these results to indicate a greater absorption of nitrogen by the crop on soil having less moisture, but results of this nature are cited elsewhere in this bulletin.

INFLUENCE OF SIZE OR WEIGHT OF THE SEED-WHEAT KERNEL UPON THE CROP YIELD.

Sanborn[c] reports experiments to ascertain the effect of separating seed wheat into kernels of different grades to ascertain the effect upon the yield. He divided the kernels into large, medium, small, ordinary (grain as it came from the thrasher), and shriveled, and continued the experiments for four years. Apparently the large kernels were separated from the crop grown from large seed the previous year, and

[a] Utah Experiment Station Bulletin 80.

[b] Nitrogen has been calculated from proteids by dividing by 6.25.

[c] Utah Experiment Station Report, 1893, p. 168.

so with the other classes of kernels. He tabulates his results as follows:

Kind of seed.	Yield of grain on plots (in pounds).				Average for 4 years.
	1890.	1891.	1892.	1893.	Bushels per acre.
Large	88.5	72.5	111	63.0	18.72
Medium	....	70.0	87	67.0	16.60
Small	94.0	105.0	64	74.0	18.72
Ordinary	84.0	95.0	87	29.5	16.42
Shriveled	....	43.0	78	31.0	11.25

The relation between yields of the crops representing different sized kernels is so irregular from year to year that suspicion is aroused regarding the accuracy of the results, due to lack of uniformity in soil. Sanborn's conclusion is that very little, if any, advantage is to be gained by separating seed wheat and planting the large kernels.

At the Indiana Experiment Station, Latta[a] conducted experiments in which wheat was separated by means of a fanning mill into heavy and light kernels, but impurities and chaffy seed were fanned out of each lot of wheat. The experiments were continued three years, but the separations were made each year from seed that had not been so separated the year before. The average gain from the large seed for three years was 2.5 bushels per acre.

Georgeson,[b] at the Kansas station, seeded plots of land with (1) light seed weighing 56 pounds per bushel, (2) common seed weighing 62.5 pounds, (3) heavy seed weighing 63 pounds, and (4) selected seed, obtained by picking the largest and finest heads in the field just before the crop was cut, weighing 61.5 pounds per bushel. Seed was separated each year from wheat not grown from previously selected seed. The average results for three years were as follows:

Grade of seed.	Yield of grain per acre (bushels).	Grade of seed.	Yield of grain per acre (bushels).
Light	25.19	Heavy	27.07
Common	26.57	Select (average for 2 years)	25.82

Desprez[c] reports experiments extending through three years in which large kernels were selected from a crop grown from large seed

[a] Indiana Experiment Station Bulletin 36, pp. 110–128.

[b] Kansas Experiment Station Bulletin 40, pp. 51–62.

[c] Abstract, Experiment Station Record, 7, p. 679, from Jour. Agr. Prat., 59 (1895), 2, pp. 694–698.

for several years and small seed from a crop grown from small seed for several years. Five varieties of wheat were used. The average results for three years were a difference of 1,067 to 1,828 kilograms of grain per hectare in favor of the large seed, but the difference was in general greater the first year than later. The use of large seed gave a crop with kernels larger than those grown from small seed.

Middleton[a] reports the yields obtained from large wheat kernels to be almost double those obtained from small seed kernels.

Bolley,[b] as the results of experiments continuing for four years in which plump kernels of large size and plump kernels of small size were selected for seed, concludes that "perfect grains of large size and greatest weight produce better plants than perfect grains of small size and light weight, even when the grains come from the same head."

At the Ontario Agricultural College, Zavitz[c] selected large plump seed, small plump seed, and shrunken seed of both spring and winter wheat. Experiments were continued for eight years with spring wheat and five years with winter wheat, the selections each year being from a crop grown from previously unselected seed. His results are as follows:

Kind of seed.	Yield per acre (in bushels).	
	Spring wheat.	Winter wheat.
Large, plump	21.7	42.4
Small, plump	18.0	34.8
Shrunken	16.7	33.7

Dehérain and Dupont[d] report that the yields from small and large kernels of a number of varieties of wheat were in all cases in favor of the large kernels, but a large difference in yield was obtained only when there was a marked difference in the weight of the kernels.

Soule and Vanatter[e] conducted experiments for three years in which large and small kernels were separated by means of sieves. In addition a plot of unselected seed was planted. The large seed was, each year after the first, selected from the crop grown from large seed the previous year. The same was true of the small seed. These investigators say:

[a] Abstract, Experiment Station Record, 12, p. 441, from Univ. Coll. of Wales Rept., 1899, pp. 68–70.

[b] North Dakota Experiment Station Report, 1901, p. 30.

[c] Ontario Agricultural College and Experiment Farm Report, 1901, p. 84.

[d] Abstract, Experiment Station Record, 15, p. 672, from Compt. Rend., 135 (1902), p. 654.

[e] Tennessee Experiment Station Bulletin, vol. 16, No. 4, p. 77.

The average difference in yield at the end of three years between large grains (607 per ounce), commercial sample (689 per ounce), and small grains (882 per ounce), with Mediterranean wheat, was 2.06 bushels in favor of large grains as compared with the commercial sample, and 5.18 bushels in favor of large grains over small grains. The difference in yield between the large grains and the commercial sample chiefly occurred the first year; but it is possible, though hardly probable, that the difference was partly due to variation in the soil. The experiment has been carried on in different parts of the field for the last two years, and the difference in yield is now only 0.32 bushel per acre in favor of the large grains.

Cobb[a] reports tests of various grades of wheat kernels with respect to size, and concludes that large kernels give better yields of grain. The seed of one year was not the product of the corresponding grade of the previous one.

Grenfell[b] selected plump and shriveled kernels from the same bulk of grain. Of these 150 kernels were sown in each row, with rows of plump and shriveled kernels alternating. The germination in both rows appeared much alike, but the plants in the rows sown from plump grain soon began to gain on the others and kept ahead for the remainder of the season. The tillering was better in the plump-grain plants. Grenfell tabulates his results thus:

Variety.	Kind.	Percentage of plants that grew.	Number of heads.	Tillering power.	Average yield per acre (bushels).
Steinwedel	Plump	96.0	179	1.24	10.9
Do	Shriveled	89.3	174	1.29	9.9
Purple Straw	do	89.3	153	1.14	6.1
Do	Plump	90.0	200	1.49	10
Do	Shriveled	76.0	140	1.16	6.9
Do	Plump	92.0	161	1.23	8.4
Do	Shriveled	98.0	155	1.34	7.2
Plump-kernel averages		92.7	180	1.32	9.8
Shriveled-kernel averages		88.5	155	1.23	7.5

As bearing upon this subject some experiments conducted by Rünker[c] are of interest. He weighed each of the kernels of a large number of heads of wheat of the Spalding Prolific and Martin Amber varieties, and found that the heaviest kernels occur in the lower half of the spike. With spikes of different lengths and weights, the weight of the average kernel increases with the size of the spike.

Weights of individual kernels from the same spikes show that there is a great range in this respect. One spike, of which Rünker gives the weights of all the kernels, and which is given as representative of the average, shows kernels varying in weight from 36 to 71 milligrams.

[a] Agricultural Gazette of New South Wales, 14 (1903), No. 2, pp. 145–169.

[b] Agricultural Gazette of New South Wales, 12 (1901), No. 9, pp. 1053–1062.

[c] Jour. f. Landw., 38 (1890), p. 309.

It is therefore quite evident that a sample of wheat taken from spikes of different sizes when separated into lots of light and heavy kernels would have both the larger spikes and smaller spikes represented in each lot of kernels, but doubtless the proportion of kernels from large heads would be greater in the lot of heavy kernels.

It would appear from these results that the evidence was overwhelmingly in favor of large or heavy wheat kernels for seed. Most of the experimenters selected seed of different kinds each year without reference to previous selection. If large seed or small seed represent plants of different characteristics and if these properties are hereditary, the results of selection of large or small seeds for several years may be quite different from what they would be the first year. It is only those experiments in which selection of the same kind of seed has been continued for several generations that may be relied upon to indicate the value of continuous selection of large kernels for seed.

Such experiments have been conducted by Sanborn, by Desprez, and by Soule and Vanatter. The work of Desprez indicates that the size of the kernel is a hereditary quality. That being the case, it is evident that the small seed of the first separation may be composed partly of seed that is small on account of immaturity and partly of seed that is small by inheritance, but which is perfectly normal. When such seed is planted the immature seed will be largely eliminated in the crop, but the naturally small seed will have reproduced itself and will compose most of the crop. When the seed is again separated a much smaller percentage of small seed will be immature, and in consequence a larger number of kernels will produce plants. It would appear from Desprez's experiments, however, that those plants producing small kernels are not so prolific as those producing large kernels.

Sanborn's results make a very good showing for the small kernels, but, as before stated, the extreme irregularity would lead to the belief that the soil on the plots lacked uniformity, or that some other errors had influenced the results. To offset this the tests cover a period of four years, which should help to rectify mistakes, and in consequence the good showing made by the small kernels is entitled to some consideration.

Soule and Vanatter's results fulfill exactly the conditions of the hypothesis that the small seed would the first year contain a much larger proportion of immature kernels than it would in subsequent years, and hence yield more poorly the first year. Their results with heavy kernels as compared with ordinary seed offer little encouragement to the continuous selection of large kernels.

The fact before referred to that both large and small kernels are found on the same head of wheat is perhaps an argument against the superior value of large seed. If the plant and not the seed is the unit of reproduction, small seed from a plant whose kernels averaged large size may be better than large seed from a plant whose kernels averaged small size.

On the other hand, there can be no doubt that the majority of the kernels in the lot of heavy kernels would be from plants having large spikes, and vice versa. This would give the kernels in the heavy lot some advantage. Again, the advantage that the large kernel is supposed to possess for seed may not be in producing a large kernel in the resulting crop, but in giving the plant a better start in life, or producing a more vigorous plant.

RELATION OF SIZE OF KERNEL TO NITROGEN CONTENT.

Richardson[a] has made a large number of analyses of wheats from different parts of the United States. The weight of 100 kernels was also determined in each sample. There can not be said to be any constant relation between the nitrogen content and the kernel weight, but in the main the large kernels have a lower percentage of nitrogen than the small kernels, and inversely.

Pagnoul[b] reports that in a test of eleven varieties of wheat there was in the main a decrease in the percentage of nitrogen in the crop as compared with the seed when there was an increase in the weight of 1,000 kernels in the crop as compared with the seed.

The same investigator[c] again states that in an examination of seventy varieties of wheat there was no constant relation between the size of the kernels and their nitrogen content, but that in general the varieties with small kernels were the varieties richest in nitrogen.

Marek[d] separated wheat of the same variety into lots of large and of small kernels. He found on analysis that the large kernels contained 12.52 per cent protein and the small kernels 13.55 per cent protein.

Woods and Merrill[e] made analyses of a number of wheats grown in Minnesota and of the same varieties grown in Maine. The wheats uniformly developed a larger kernel when grown in Maine. Grouping five varieties raised in Minnesota and five raised in Maine, it will be seen that with this increase in the size of the kernel there was a

[a] U. S. Department of Agriculture, Division of Chemistry, Bulletins 1 and 3.

[b] Abstract in Centrlb. f. Agr. Chem., 1893, p. 616, from Ann. Agron., 1892, p. 486.

[c] Abstract in Centrlb. f. Agr. Chem., 1888, p. 767, from Ann. Agron., 14, pp. 262–272.

[d] Abstract in Centrlb. f. Agr. Chem., 1876, from Landw. Zeitung f. Westfalen u. Lippe, 1875, p. 362.

[e] Maine Experiment Station Bulletin 97.

decrease in the nitrogen content. The analyses, reduced to a water-free basis, are as follows:

Where grown.	Weight of 100 kernels (grams).	Percentage of protein.
Minnesota	2.239	16.22
Maine	3.109	15.43

In a review of the experiments concerning the relation of weight to composition of cereals, Gwallig[a] says that the results obtained by Marek, Wollny, Märcker, Hoffmeister, and Nothwang divide barley and rye into one group, and wheat and oats into another, as regards this relation. With barley and rye, the largest, heaviest kernels are the richest in protein. With wheat and oats, the smallest, lightest kernels have the highest protein content.

Gwallig says further that with an increased protein content there is a decrease in nitrogen-free extract. The fat and ash do not stand in a definite relation to the kernel weight, but the small, light kernels have a higher percentage of crude fiber, which circumstance is accounted for by the larger surface possessed by the smaller kernels.

Snyder[b] has divided small kernels into two classes—those which are small because shrunken and those which are small although well filled. He finds that as between small kernels of the first class and large, well-filled kernels, the former contain a higher percentage of nitrogen, but as between the small, well-filled and the large, well-filled kernels, the latter contain the higher percentage of nitrogen. In testing this he used large and small kernels of the same variety in each case, and the wheats represented a large portion of the wheat-growing area of the United States. As regards the relation of large, perfect, and small, perfect kernels there were twenty-four out of twenty-seven cases in which the large kernels contained a greater percentage of nitrogen.

Johannsen and Weis,[c] in experiments with five varieties of wheat, find that as a general rule the percentage of nitrogen is increased with increasing grain weight, but that there are many exceptions to the rule.

Cobb[d] states that small wheat kernels contain a larger proportion of gluten than do large ones, but he does not submit any analyses to substantiate his statement.

[a] Abstract in Centrlb. f. Agr. Chem., 24 (1895), p. 388, from Landw. Jahrbücher, 23 (1894), p. 835.

[b] Minnesota Experiment Station Bulletin 85.

[c] Abstract, Experiment Station Record, 12, p. 327, from Tidsskr. Landbr. Planteavl., 5 (1899), pp. 91–100.

[d] Agricultural Gazette of New South Wales, 5 (1894), No. 4, pp. 239–250.

Körnicke and Werner[a] quote the experiments of Reiset to show that shriveled kernels have a higher nitrogen content than plump ones. With different varieties of wheat he found the following:

Variety.	Kind.	Percentage of nitrogen in dry matter.
Spalding	Shriveled	2.48
Do	Plump	2.33
Victoria	Shriveled	2.44
Do	Plump	2.08
Albert	Shriveled	2.59
Do	Plump	2.35

Carleton[b] records the weight of 100 kernels and the percentage of "albuminoids" in sixty-one samples of wheat from various parts of the world. Dividing these into classes according to the weight of 100 kernels we have the following:

Weight of 100 kernels (grams).	Average weight of kernels (grams).	Percentage of albuminoids.	Number of samples.
2 to 3	2.66	14.58	6
3 to 4	3.67	12.31	25
over 4	4.57	11.62	30

Reviewing these experiments there would seem to be no doubt that shrunken kernels contain a higher percentage of nitrogen than do well-filled ones, but as between large and small kernels, both of which are well filled, there is not a great deal of information. Snyder's experiments are the only ones that cover this ground, but they are extensive and very uniform, and may be considered as deciding the question in favor of a higher nitrogen content for the large kernels, so far as small, plump kernels and large, plump kernels are concerned. But, as small and light kernels are usually not plump, taking the crop as a whole and dividing it equally into large and small or heavy and light kernels, the evidence would be in favor of the small or light kernels for high nitrogen content. As between wheats from different regions and of different varieties, those having small kernels are generally of higher nitrogen content.

INFLUENCE OF THE SPECIFIC GRAVITY OF THE SEED KERNEL UPON YIELD.

Sanborn[c] separated seed wheat with a sieve into large, medium, small, and shriveled kernels. The large seed was separated by means

[a] Handbuch des Getreidebaues, 1, pp. 520–521, Berlin, 1884.

[b] U. S. Department of Agriculture, Division of Vegetable Physiology and Pathology, Bulletin 24.

[c] Abstract, Experiment Station Record, 5, p. 58, from Utah Experiment Station Report, 1892, pp. 133–135.

of a brine solution into two nearly equal parts. The seed thus separated was planted on separate plots. The experiment was continued three years. The heavy seed yielded 10.8 bushels and the light 16.3 bushels per acre. Unselected seed yielded 16.4 bushels per acre.

Seed wheat of four varieties was separated by Church[a] by means of solutions of calcium chlorid having specific gravities of 1.247, 1.293, and 1.31. The seed was first treated with a solution of mercuric chlorid to remove adherent air. Each lot of seed was planted separately. From the results the following conclusions are drawn:

(1) The seed wheat of the greatest density produced the densest seed.

(2) The seed wheat of the greatest density yielded the largest amount of dressed grain.

(3) The seed of medium density generally gave the largest number of ears, but the ears were poorer than those from the densest seed.

(4) Seed of medium density generally produced the largest number of fruiting plants.

(5) The seed wheat that sank in water, but floated in a solution having the density 1.247, was of very low value, yielding on an average only 34.4 pounds of dressed grain for every 100 yielded by the densest seed.

Haberlandt,[b] as the result of experiments with several cereals, has shown that the comparative weight of kernels is transmitted to the grain resulting from this seed. This was the case with wheat, rye, barley, and oats. The results with wheat were as follows:

Number of pounds.	Weight of kernels.		
	Light.	Medium.	Heavy.
	Grams.	*Grams.*	*Grams.*
1,000 seed kernels	29.5	31.2	33.0
1,000 crop kernels	34.3	35.5	36.3

Wollny[c] objects to the results of the experiments by F. Haberlandt, Church, Trommer, Hellriegel, and Ph. Dietrich with various cereals, in which almost without exception the kernels of high specific gravity produced the best yields, because no distinction was made between absolute weight and specific gravity in the kernels. He claims that the value of the seed lies in the kernels of absolutely heavy weight rather than in the kernels of high specific gravity. He concludes that the specific gravity of the seed exerts no influence on the yield of the crop.

[a] Science with Practice.

[b] Jahresb. Agr. Chem., 1866–67, p. 298.

[c] Abstract in Centrlb. f. Agr. Chem., 1887, p. 169, from Forschungen a. d. Gebiete Agrikulturphysik, 9 (1886), pp. 207–216.

In the light of the experiments that have been conducted with seed wheat of high and low specific gravities, it would appear that, in general, seed of very low specific gravity does not yield well, and it is evident that such seed must be deficient in mineral matter and is probably not normal in other respects. There would not appear, however, to be any marked difference in the productive capacity of kernels of medium specific gravity and kernels of great specific gravity.

RELATION OF SPECIFIC GRAVITY OF KERNEL TO NITROGEN CONTENT.

Marek[a] found that with an increase in the specific gravity of the kernel there was a decrease in nitrogen content.

Pagnoul,[b] in testing seventy varieties of wheat, found that the nitrogen content rose with the specific gravity, but not regularly, and that a definite relation could not be traced.

Wollny[c] took kernels of horny structure and kernels of mealy structure. He says it is generally recognized that the hard, horny kernels have a higher specific gravity, and that it is commonly attributed to their higher content of proteids. He contends that as starch has a higher specific gravity than protein the mealy kernels must really have a higher specific gravity than the horny ones.

Körnicke and Werner[d] state the specific gravities of the various chemical constituents of the wheat kernel as follows: Starch, 1.53; sugar, 1.60; cellulose, 1.53; fats, 0.91 to 0.96; gluten, 1.297; ash, 2.50; water, 1.00; air, 0.001293. They state also (p. 121) that the specific gravity of the kernel does not stand in any relation to the volume weight, for the factor which results from weighing a certain volume mass is influenced by the air spaces between the kernels, and these depend upon the form and size as well as the surface and accidental structure of the kernel. They also contend that there is no relation between the volume weight and the content of proteid material.

Schindler[e] shows that by tabulating a large number of varieties of wheat from different parts of the world, and representing different varieties, there is no relation between the weight of 1,000 kernels and the volume weight of 100 c. c. By separating these into varieties, even when grown in different localities, kernels of the same variety did show a definite and constant relation. The volume weight increased with an increase in the weight of 1,000 kernels.

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[a] Abstract in Centrlb. f. Agr. Chem., 1876, p. 46, from Landw. Zeitung f. Westfalen u. Lippe, 1875, p. 362.

[b] Abstract in Centrlb. f. Agr. Chem., 1888, p. 767, from Ann. Agron., 14, pp. 262–272.

[c] Abstract in Centrlb. f. Agr. Chem., 1887, p. 169, from Forschungen a. d. Gebiete Agrikulturphysik, 9 (1886), pp. 207–216.

[d] Handbuch des Getreidebaues, 2, p. 120, Berlin, 1884.

[e] Jour. Landw., 45 (1897), p. 61.

There has long been a desire manifested by workers in this field to establish some definite relation between the specific gravity of the wheat kernel and its composition, or at least its nitrogen content. Very contradictory results have been obtained by several experimenters, and little progress has been made.

It is true that the various chemical constituents that go to compose the wheat kernel have different specific gravities, and as those of the carbohydrates are all less than those of the proteids it might be argued that a wheat having a large proportion of proteid material would have a low specific gravity. However, the specific gravity of the ash is so much greater than that of any other constituent and the ash in wheats from different soils and climates varies so much that these factors completely prevent the establishment of a definite relation. The size and number of the vacuoles also influence the specific gravity.

In general, it may be said that as between kernels of the same variety grown in the same season and upon the same soil, the specific gravity is inversely proportional to the nitrogen content.

CONDITIONS AFFECTING THE PRODUCTION OF NITROGEN IN THE GRAIN.

So far as the writer has been able to ascertain there is no literature bearing directly upon the conditions affecting the production of nitrogen in the grain of wheat.

Regarding high nitrogen in the wheat crop as arising merely from failure on the part of the kernel to develop fully, it would seem that a high percentage of nitrogen would inevitably be accompanied by a small production of nitrogen per acre. This, however, does not always appear to be the case.

Taking, for instance, the yields of wheat obtained by Lawes and Gilbert[a] for a period of twenty years, which they divide into two periods of good and of poor crops, each covering ten years, we have the following figures:

Seasons.	Average yield of grain per acre (pounds).	Weight per bushel (pounds).	Yield of nitrogen per acre (pounds).
Good crop seasons	1,833	60.2	28.0
Poor crop seasons	1,740	57.1	29.8

It will be noticed that the largest production of nitrogen per acre was in those years in which the weight per bushel and the yield per acre were least.

Of course this is not always the case, but that it should occur at all is an indication that the conditions that make for high nitrogen

[a] On the Composition of the Ash of Wheat Grain and Wheat Straw, London, 1884.

content in the grain also conduce to a large accumulation of nitrogen by the crop, or perhaps it would be more accurate to say that the conditions which favor a large accumulation of nitrogen by the crop often result in giving it a high nitrogen content.

Reference has already been made to the observations of Dehérain and Dupont[a] on the wheat crops of 1888 and 1889 at Grignon. The figures for the yields of grain, the percentages of starch and gluten, and the production per acre of these constituents for the two years are as follows:

Year.	Yield of grain per hectare (kilos).	Percentage of—		Gluten per hectare (kilos).	Starch per hectare (kilos).
		Gluten.	Starch.		
1888	3,445	12.6	77.2	434	2,659
1889	2,922	15.3	61.9	447	1,808

From this it will be seen that for the year in which the yield of grain was less per acre the production of gluten per acre was greater. Apparently the conditions were favorable for a large accumulation of nitrogen by the plant in 1889, but were unfavorable to the production of starch. If the latter had not been the case, the crop of 1889 would have been larger than the crop of 1888.

A number of instances of this kind have occurred among the wheat crops at the Nebraska Experiment Station. In fact, it may be said that, in general, large yields of grain have there been accompanied by a low percentage of nitrogen per acre as compared with the same properties in small yields of grain. The following table will show this:

Production of nitrogen per acre in wheat raised at the Nebraska Experiment Station.

Variety.	Year.	Yield of grain per acre (pounds).	Percentage of proteid nitrogen.	Proteid nitrogen per acre (pounds).	Date of ripening.
Turkish Red	1900	1,980	3.02	52.73	June 27
Do	1901	2,370	2.00	43.04	June 24
Do	1902	1,800	2.86	51.48	June 23
Do	1903	1,864	2.40	44.74	July 9
Yaroslav	1900	1,320	3.01	34.58	July 2
Do	1901	1,794	2.18	36.08	July 1
Do	1903	[a] 962	2.54	24.43	July 14
Weissenburg	1902	1,605	3.16	46.32	June 24
Do	1903	1,891	2.10	39.71	July 10
Pester Boden	1902	1,475	2.92	43.10	June 24
Do	1903	1,830	2.16	39.53	July 10
Average	....	1,717	....	41.43	

[a] Yield decreased by lodging of grain.

A word in regard to the character of the seasons that produced these crops may help to an understanding of their differences.

[a] Ann. Agron., 28 (1902), p. 522.

The season of 1900 was rather dry and hot from the time growth started in the spring until harvest. There was no time when there was an abundant supply of moisture, but occasional rains wet the soil for a few days at a time. The temperatures during the day were high and the air was dry. In 1901 the spring was quite moist and cool until June, when it became extremely hot and dry. A few days before harvest the temperatures ranged above 100° F. daily, with no rainfall. The season of 1902 was the direct opposite of that of 1901, except that the change came earlier. It was extremely dry and hot until the middle of May, when abundant rains came, and the temperatures were considerably below normal until harvest. The season of 1903 was wet and cool throughout.

In general, it may be said that in those seasons, like 1900 and 1902, in which the temperatures were high and moisture scarce during all or the early part of the growing season, the grain had a high percentage of nitrogen, and there was a large production of nitrogen per acre. In years of low temperatures and abundant moisture, as in 1903, or even when such conditions obtained late in the season, as in 1901, there were a low percentage of nitrogen in the grain and a small production of nitrogen per acre.

High temperatures and scant moisture during early growth would, therefore, seem to favor the accumulation of nitrogen by the wheat plant.

It may also be noted that these are the conditions favorable to the process of nitrification and to the accumulation of nitrates near the surface of the soil.

Comparing the wheat crops grown at Rothamsted for a period of twenty years, the yields and nitrogen production of which have just been stated, with the averages for the Nebraska-grown wheats contained in the last table, it will be seen that the yields of grain were larger at Rothamsted, but that the production of nitrogen per acre was considerably greater in Nebraska.[a]

Station.	Yield (in pounds) per acre of—	
	Grain.	Nitrogen.
Rothamsted station	1,786	28.9
Nebraska station	1,717	41.4

The maximum production of nitrogen per acre at Rothamsted during the twenty years was 38.1 pounds, while at Nebraska it was 52.7 pounds.

There can be little doubt as to whether this difference was due in greater measure to soil fertility or to climate. Nowhere is better

[a] The yield of nitrogen at Rothamsted is calculated from total organic nitrogen, while at the Nebraska Station it is from proteid nitrogen.

tillage given or are crops more scientifically provided with food than at Rothamsted. It is true that of the ten plots of land on which these wheats were raised one received no manure and three were not sufficiently manured. In order to make the comparison more favorable to the English environment, the five plots completely manured and producing the largest yields may be taken. The yield of nitrogen per acre was 36.4 pounds for the years 1852–1861 and 34.6 pounds for 1862–1871. Even with the best manuring the yields of nitrogen fall very much short of those in Nebraska.

In Nebraska no commercial fertilizers had ever been used on the land on which the wheats were grown, but farm manure had been applied. The soil was a heavy one, well adapted to wheat growing, and had been well tilled. It had been well manured for corn in a rotation of corn, oats, and wheat. The varieties, with the exception of Turkish Red, had just been introduced from Europe and had not fully adapted themselves to the new environment. The average nitrogen production for the only acclimated variety, Turkish Red, was 48 pounds per acre. It would seem, therefore, that a climate affording high temperatures, dry air, and a moderately dry soil is favorable to the accumulation of a large amount of nitrogen by the wheat plant, provided there is a large supply of nitrogen in the soil.

The heat and scant soil moisture are doubtless instrumental in making available the nitrogen of the humus, and the bright sunshine and dry, hot air stimulate growth and increase transpiration.

It has just been said that hot, dry weather in the early growing season contributes to a large nitrogen accumulation by the wheat plant. The same conditions cut short the growing period of the plant and prevent the large accumulation of starch that takes place in the kernel of wheat raised in a cool or moist region. It thus happens that such wheats are high in nitrogen and low in starch.

The properties of the wheat kernel characteristic of a continental climate and rich soil are probably due to rapid nitrification and highly stimulated growth causing a large accumulation of nitrogen by the crop, and to incomplete maturation, caused either by heat, or frost, or lack of moisture, resulting in high nitrogen.

It would be interesting to know what relation the production of nitrogen per acre bears to the production of mineral matter, but the necessary figures are not at hand.

The wheat kernel produced in a continental climate is not usually plump as compared with the kernel produced in an insular or coastal one. The yield of grain per acre is also usually less. That this is due to incomplete maturation is shown by the fact that winter varieties of wheat that make their growth early in the season always yield better than spring varieties. The latter, on the other hand, have a higher percentage of nitrogen, but usually not so large a

nitrogen production. Their disadvantage lies in the fact that their roots are not sufficiently developed to absorb a large quantity of nitrogenous matter at the time most favorable for its accumulation. As a maximum nitrogen accumulation is the chief desideratum, spring wheats are not desirable where winter ones can be grown.

This does not mean that a variety of wheat which has been grown, for instance, in England will show all the qualities of an inland wheat when first grown in Kansas or Nebraska. Such a wheat will undergo modifications that will give it some of these qualities, such, for instance, as less well-filled kernels, and less weight per bushel. On the other hand, the Turkish Red wheat, when raised in a cool, moist climate, becomes later maturing, and the kernel becomes plumper, more starchy, and softer. It is between varieties adapted each to its peculiar climate, and raised there for years, that these distinctions are most marked, but the fact that a modification of any variety begins at once when transferred from one climate to another shows that such qualities as those mentioned are influenced by the climate.

It must be quite apparent, although it has not often been remarked, that the ordinary selection of seed wheat to increase the yield has resulted in producing a grain of lower nitrogen content.

This has been noticed by Girard and Lindet[a] and by Biffen,[b] and incidentally by Balland,[c] who, in commenting on the decrease in the nitrogen content of wheat in northern France and the increased yields, attributes the former to a deficiency of nitrogen in the fertilizers used, and states that the gluten in the wheat of that region in 1848 ranged from 10.23 to 13.02 per cent, while fifty years later it ranged from 8.96 to 10.62 per cent. In the same time the average yield increased from 14 to 17.5 hectoliters per hectare. In the light of the results of experiments to ascertain the effect of nitrogenous fertilizers upon the composition of wheat, it can not be supposed that this decrease in nitrogen content can be due primarily to lack of nitrogen. It would seem more likely that the increased yield was largely due to the deposition of starch in the grain, and that consequently the percentage of gluten was smaller.

Has the improvement in the yield of wheat been accompanied by a greater yield of nitrogen per acre? It is evident that the increase in the grain and that in the nitrogen are not proportional, but it is

[a] Le Froment et sa Monture, Paris, 1903.

[b] Nature (London), 69 (1903), No. 1778, pp. 92, 93.

[c] Abstract in Centrlb. f. Agr. Chem., 1897, p. 785, from Compt. Rend., 124 (1897), p. 158.

desirable to know whether there has been any increase in nitrogen per acre. Returning to the figures given by Balland it will be seen that the wheat of 1848 produced on an average 163 kilos per hectare, while that of fifty years later produced 171 kilos, an increase of about 5 per cent in gluten per hectare, with an increase of 25 per cent in yield. These figures can not, of course, be taken as strictly accurate, as they are based merely on what M. Balland refers to as the range of nitrogen content.

Some data on this subject are available in the published records of wheat improvement at the Minnesota Experiment Station.[a] Yields and gluten content of improved varieties and of the original variety from which the improved strains have been developed by selection are given. The figures cover the same seasons for all varieties, and the averages of six trials are reported for each, as follows:

Variety.	Yield per acre (bushels).	Percentage of dry gluten.	Gluten per acre (pounds).	Nitrogen per acre (pounds).
Minnesota No. 149, produced from Power's Fife	25.6	13.5	207.4	36.4
Power's Fife, unmodified by selection	23.6	14.0	198.2	34.8
Minnesota No. 169, produced from Hayne's Blue Stem	28.5	12.5	213.7	37.5
Hayne's Blue Stem, unmodified by selection	24.6	13.4	198.8	34.7

In each case the new variety yielded more grain per acre, possessed a lower gluten content, and produced more nitrogen per acre in the grain. It should be explained that determinations of gluten and baking tests were made of strains of wheat produced by the selection of individual plants, and that the quantity and quality of the gluten in these strains were considered in deciding which strain was to be perpetuated. For that reason the gluten content of the improved wheat is doubtless greater than it would have been if no attention had been paid to those qualities. Incidentally it may be stated that the quality of the gluten in these new varieties of wheat originated by Professor Hays is much better than that in the original varieties. The difference between selection for gluten carried on in this way and selection for gluten applied to the individual plant is that the latter must increase many times the opportunity for developing a strain of desirable gluten content.

Returning to the nitrogen production per acre, it is apparent that it is slightly greater in the improved wheats, or at least is not less than in the original varieties. This is encouraging, as it indicates the possibility of increasing the production of gluten per acre.

[a] Minnesota Experiment Station Bulletin 63.

Gluten is the valuable constituent of wheat. The wheat growing of the future may be looked upon as a gluten-producing industry. The problem is to secure the highest possible quantity and quality of gluten per acre. If this can be done by sacrificing starch production, it will be economical. Starch can be more cheaply produced in other crops and, if necessary, added to the flour of wheat.

It may be argued that this is not to the interest of the farmer. But it is clearly to the interest of mankind and any step toward its accomplishment must in the end redound to the advantage of the farmer.

PART II.

EXPERIMENTAL.

SOME PROPERTIES OF THE WHEAT KERNEL.

If a number of wheat kernels of the same variety and raised under similar conditions are separated into approximately equal parts with regard to their specific gravity, the kernels of low specific gravity will be found to contain a higher percentage of both total and proteid nitrogen than the kernels having a high specific gravity.

A number of samples of wheat grown in different years and representing different varieties were separated into approximately equal parts by throwing the kernels into a solution of calcium chlorid having such a density that about half the kernels would float and the other half sink. The specific gravity of the solution in which each sample was separated is given in Table 1 and the signs < and > are used to represent "less than" and "greater than," respectively. Thus "<1.29" means that the kernels have a specific gravity of less than 1.29, while ">1.29" indicates that the kernels have a specific gravity greater than 1.29.

TABLE 1.—*Analyses of kernels of high and of low specific gravity.*

Serial number.	Specific gravity.	Percentage of— Total nitrogen.	Proteid nitrogen.[a]	Nonproteid nitrogen.	Name of variety and year of growth.
1	<1.290	3.51	2.49	1.02	Hickman, grown in 1895.
2	>1.290	3.27	2.39	.88	
30	<1.286	2.51	1.88	.63	Turkish Red, grown in 1897.
31	>1.286	2.51	1.94	.57	
38	<1.250	2.80	2.26	.54	Spring wheat, Marvel, grown in 1897.
39	>1.250	2.78	2.15	.63	
40	<1.265	2.95	2.13	.82	Spring wheat, Velvet Chaff grown in 1897.
41	>1.265	2.66	2.01	.65	
59	<1.264	3.30	2.41	.89	Turkish Red, grown in 1898.
60	>1.264	3.06	2.29	.77	

[a] Proteid nitrogen in this paper = nitrogen by Stutzer's method. Proteids = proteid nitrogen × 5.7.

With the exception of serial Nos. 30 and 31 the kernels of low specific gravity have in each case a higher percentage of both total and proteid nitrogen than have the kernels of high specific gravity. It will also be noticed that the percentage of nonproteid nitrogen is greater in the kernels of low specific gravity.

Samples of wheat were also divided into light and heavy portions by means of a machine which operates by directing upward a current of air, the velocity of which can be regulated. Into this current the grain is directed. The result is that the heavy kernels and the large

kernels fall, and the light kernels and small kernels are driven out. The separation thus accomplished is somewhat different from that effected by a solution, the difference being that the latter separates the kernels entirely according to their specific gravities while with the air blast a large kernel of a certain specific gravity might descend with the heavy kernels, when if it were smaller, although of the same specific gravity, it would be blown out.

The number of light kernels that descend on account of their large size is relatively small, owing to the fact that large kernels are, as a rule, of higher specific gravity than small ones. The following test was made to determine the relation between the size of wheat kernels and their specific gravity. An average lot of wheat was nearly equally divided by means of two sieves into three portions representing medium, small, and large kernels. Each of these portions was then thrown upon solutions of the same specific gravity, and the proportion by weight that floated, or light seed, and the proportion that sank, or heavy seed, were determined.

TABLE 2.—*Proportion of light and of heavy seed.*

Kind of seed.	Heavy seed (grams).	Light seed (grams).	Ratio.	
			Heavy.	Light.
Small	8.72	11.28	1	1.29
Medium	9.62	10.78	1	1.12
Large	11.96	8.04	1	.67

The weight of light kernels among the small was nearly twice that of light kernels among the large seeds.

Analyses of samples of wheat separated by this machine into light and heavy kernels gave about the same results as the samples separated by solutions of certain specific gravities.

TABLE 3.—*Analyses of large, heavy kernels and of small, light kernels.*

Serial number.	Relative weight.	Percentage of—			Name of variety and year of growth.
		Total nitrogen.	Proteid nitrogen.	Nonproteid nitrogen.	
9	Light	2.99	2.21	0.78	Spring wheat, Marvel, grown in 1896.
10	Heavy	2.76	2.04	.72	
57	Light	2.77	2.11	.66	Currell, grown in 1898.
58	Heavy	2.70	2.04	.66	
65	Light	2.91	2.29	.62	Spring wheat, grown in 1898.
66	Heavy	2.65	2.04	.61	
80	Light	2.45	2.00	.45	Big Frame, grown in 1899.
81	Heavy	2.19	1.96	.23	
383	Light	3.12	3.10	.02	Turkish Red, grown in 1900.
384	Heavy	3.02	2.93	.09	
385	Light	3.13	2.82	.31	Big Frame, grown in 1900.
386	Heavy	2.95	2.65	.30	
602	Light	3.30	3.06	.24	Big Frame, grown in 1901.
603	Heavy	2.46	2.24	.22	
613	Light	2.35	2.13	.22	Turkish Red, grown in 1901.
612	Heavy	2.11	1.94	.17	

It thus becomes very apparent that the percentage of nitrogen is relatively greater in the light wheat selected in the manner described.

It is well known that immature wheat is of lighter weight than mature wheat and that it contains a greater percentage of nonproteid nitrogen. In a field of wheat there are always certain plants that mature early, others that mature late, and some that never reach a normal state of maturity. The last condition is very likely to occur in a region of limited rainfall and intense summer heat. The conditions most favorable for the filling out of the grain are shown to be an abundance of soil moisture and a fair degree of warmth. The more nearly the conditions are the reverse of this the more shriveled the kernel and the lighter the weight. In the same variety and in the same field there are kernels that are small and shriveled because of immaturity, disease, or lack of nutriment. All of these classes would appear among the "light" kernels separated in this way.

In order to approach the question from another standpoint, a number of spikes of wheat of the Turkish Red variety were selected in the field, care being taken that all were fully ripe, and that they were composed of healthy, well-formed kernels. These spikes were sampled by removing one row of spikelets from each spike and the kernels so removed were tested for moisture, proteid nitrogen, specific gravity, and weight of kernel, and from the last two the relative volume was calculated. It will be shown later that a sample taken in this way permits of an accurate estimation of the average composition of the kernels on the spike.

The number of grams of proteid nitrogen in the row of spikelets on each spike was calculated from the data mentioned, and the average weight of the kernels on the row of spikelets was determined from their total weight and number, thus permitting of the estimation of the number of grams of proteid nitrogen in the average kernel on each spike.

In Table 4 the spikes having a proteid nitrogen content of from 2 to 2.5 per cent are arranged in one group, and on the same line with each spike are placed the number of kernels on one row of spikelets, weight of these kernels, weight of average kernel, relative volume of average kernel, specific gravity of kernel, grams of proteid nitrogen in one row of spikelets, and grams of proteid nitrogen in average kernel. Spikes having a proteid nitrogen content of from 2.5 to 3 per cent are similarly arranged, and so with all spikes up to 4 per cent. The average for each group is shown in the table.

There are, in all, 257 spikes, of which 18 have from 2 to 2.5 per cent proteid nitrogen, 82 from 2.5 to 3 per cent, 107 from 3 to 3.5 per cent, and 49 from 3.5 to 4 per cent.

TABLE 4.—*Analyses of spikes of wheat, arranged according to nitrogen content of kernels. Crop of 1902.*

Record number.	Number of kernels on row of spikelets.	Weight (in grams) of— Kernels.	Weight (in grams) of— Average kernel.	Volume of average kernel.	Specific gravity of kernels.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in— Kernels.	Proteid nitrogen (gram) in— Average kernel.
2 TO 2.5 PER CENT PROTEID NITROGEN.								
183	17	0.4772	0.0280			2.06	0.00983	0.000577
188	16	.4425	.0276			2.37	.01049	.000654
193	14	.3724	.0266			2.41	.00897	.000642
205	15	.4824	.0321	0.0241	1.3323	2.41	.01548	.000774
291	18	.5221	.0290	.0209	1.3850	2.23	.01616	.000647
304	21	.5336	.0254	.0189	1.3424	2.24	.01195	.000569
318	22	.6708	.0304	.0220	1.3853	2.02	.01354	.000614
347	15	.4549	.0303	.0216	1.4031	2.44	.01110	.000739
357	15	.4063	.0270	.0192	1.4074	2.36	.00959	.000637
358	21	.6689	.0318	.0235	1.3544	2.33	.01559	.000742
380	14	.4336	.0309	.0225	1.3735	2.35	.01019	.000726
396	19	.4787	.0251	.0183	1.3680	2.28	.01091	.000572
402	17	.4594	.0258	.0188	1.3718	2.33	.01070	.000601
406	21	.5878	.0279	.0200	1.3915	2.44	.01434	.000681
415	13	.2771	.0213			2.44	.00676	.000520
440	17	.4566	.0268			2.36	.01078	.000632
444	16	.4110	.0256			2.38	.00978	.000609
445	16	.4318	.0269			2.37	.01023	.000638
Average	17	.4759	.0266	.0209	1.374	2.323	.01141	.000643
2.5 TO 3 PER CENT PROTEID NITROGEN.								
181	19	0.4482	0.0235			2.66	0.01192	0.000625
182	17	.4299	.0252			2.76	.01187	.000696
185	19	.5041	.0265			2.71	.01366	.000718
187	15	.3945	.0263			2.99	.01180	.000786
189	18	.4871	.0270			2.64	.01286	.000713
196	17	.4995	.0293			2.71	.01354	.000794
197	20	.5683	.0284			2.85	.01620	.000809
199	17	.4589	.0269			2.99	.01372	.000804
207	15	.4584	.0305	0.0230	1.3248	2.73	.01709	.000833
210	14	.3955	.0282	.0288	1.2363	2.95	.01167	.000832
211	17	.5211	.0306	.0228	1.3416	2.90	.01511	.000887
212	15	.4298	.0286	.0211	1.3537	2.97	.01277	.000849
217	18	.6299	.0349	.0259	1.3461	2.86	.01802	.000998
218	18	.5130	.0285	.0214	1.3303	2.58	.01324	.000735
219	19	.3862	.0203	.0157	1.2950	2.71	.01047	.000550
222	19	.4611	.0242	.0182	1.3331	2.93	.01351	.000709
227	19	.5581	.0293	.0214	1.3704	2.71	.01624	.000794
229	17	.4849	.0285	.0206	1.3856	2.96	.01387	.000844
230	15	.4867	.0324	.0234	1.3815	2.54	.01236	.000823
238	17	.5166	.0303	.0220	1.3794	2.70	.01395	.000818
239	17	.3910	.0230	.01649	1.3941	2.60	.01017	.000598
241	18	.4230	.0235	.0178	1.3196	2.76	.01168	.000649
242	18	.4562	.0253	.0184	1.3753	2.96	.01350	.000749
252	19	.4898	.02578	.0186	1.3875	2.55	.01249	.000655
277	14	.3792	.0270	.0203	1.3286	2.86	.01085	.000772
288	17	.4956	.0291	.0217	1.3428	2.82	.01398	.000821
289	19	.5042	.0265	.0187	1.4155	2.53	.01276	.000670
293	17	.4858	.0285	.0206	1.3835	2.64	.01283	.000752
294	19	.4173	.0219	.0159	1.3813	2.56	.01068	.000561
302	22	.5569	.0253	.0190	1.3312	2.68	.01437	.000678
306	19	.4922	.0258	.0185	1.3996	2.51	.01235	.000650
308	15	.4951	.0330	.0237	1.392	2.85	.01411	.000941
315	16	.4994	.0312	.0224	1.3916	2.75	.01373	.000858
319	17	.4644	.0273	.0203	1.3447	2.86	.01328	.000781
320	18	.5668	.0314	.0229	1.3710	2.98	.01689	.000938
322	16	.5107	.0219	.0236	1.352	2.55	.01302	.000813
329	12	.3903	.0325	.0234	1.3911	2.88	.01241	.000936
330	17	.3431	.0201	.0161	1.2498	2.62	.00899	.000527
332	16	.4847	.0302	.0218	1.3879	2.58	.01251	.000779
334	18	.5399	.0299	.0215	1.3922	2.62	.01415	.000783
335	18	.6474	.0359	.0258	1.3928	2.82	.01826	.001012
337	15	.4497	.0299	.0215	1.3877	2.89	.01345	.000864
340	20	.4155	.0207	.0153	1.3550	2.74	.01138	.000567
341	15	.5058	.0337	.0243	1.3890	2.97	.01502	.001001
342	14	.4486	.0320	.0228	1.4037	2.60	.01166	.000832
343	13	.4112	.0316	.0224	1.4107	2.50	.01028	.000791
344	16	.4004	.0250	.0184	1.3611	2.93	.01173	.000733
345	18	.5422	.0301	.0216	1.3919	2.56	.01388	.000771
346	19	.6393	.0336	.0242	1.3913	2.55	.01630	.000857
348	18	.6328	.0351	.0262	1.3415	2.88	.01822	.001010

TABLE 4.—*Analyses of spikes of wheat, arranged according to nitrogen content of kernels. Crop of 1902*—Continued.

2.5 TO 3 PER CENT PROTEID NITROGEN—Continued.

Record number.	Number of kernels on row of spikelets.	Weight (in grams) of—		Volume of average kernel.	Specific gravity of kernels.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in—	
		Kernels.	Average kernel.				Kernels.	Average kernel.
349	17	0.4573	0.0269	0.0195	1.3822	2.66	0.01216	0.000716
350	16	.4437	.0277	.0199	1.3891	2.64	.01171	.000731
354	21	.6386	.0304	.0217	1.4002	2.73	.01743	.000830
355	16	.5008	.0313	.0223	1.4022	2.84	.01422	.000889
356	19	.5304	.0279	.0200	1.390	2.91	.01543	.000812
359	15	.3882	.0259	.0186	1.3915	2.97	.01153	.000769
360	24	.6375	.0265	.0191	1.3840	2.89	.01842	.000766
361	14	.3297	.0235	.0170	1.3819	2.94	.00969	.000691
364	18	.4724	.0262	.0191	1.3729	2.92	.01379	.000765
371	18	.5695	.0316	.0227	1.3906	2.99	.01703	.000945
373	18	.5861	.0325	.0235	1.3838	2.87	.01682	.000933
376	12	.2677	.0223	.0162	1.3747	2.60	.00696	.000580
378	14	.4099	.0292	.0212	1.3761	2.75	.01127	.000803
383	12	.3416	.0284	.0206	1.3771	2.96	.01011	.000841
386	16	.4921	.0307	.0223	1.3741	2.52	.01240	.000774
387	19	.5177	.0272	.0198	1.3758	2.73	.01413	.000743
389	21	.5830	.0277	.0204	1.3569	2.96	.01726	.000820
392	16	.3547	.0221	.0171	1.2947	2.94	.01043	.000650
393	15	.3494	.0232	.0165	1.4070	2.70	.00943	.000626
394	16	.3897	.0243	.0180	1.3508	2.77	.01079	.000673
395	17	.4805	.0282	.0206	1.3693	2.98	.01432	.000840
419	14	.3448	.0246	....	....	2.86	.00986	.000704
421	15	.3097	.0206	....	....	2.53	.00784	.000521
424	18	.4991	.0277	....	....	2.62	.01308	.000726
428	17	.4635	.0272	....	....	2.60	.01205	.000707
430	18	.5714	.0317	....	....	2.82	.01611	.000894
434	16	.4624	.0289	....	....	2.86	.01322	.000827
436	22	.6138	.0279	....	....	2.88	.01768	.000834
438	23	.6997	.0304	....	....	2.67	.01868	.000812
439	18	.5600	.0311	....	....	2.98	.01669	.000927
441	19	.5327	.0280	....	....	2.93	.01561	.000820
443	13	.4131	.0317	....	....	2.51	.01037	.000796
Average	17.07	.4791	.0279	.0207	1.3680	2.76	.01332	.000776

3 TO 3.5 PER CENT PROTEID NITROGEN.

173	20	0.5913	0.0295	....	....	3.08	0.01821	0.000909
175	21	.5773	.0274	....	....	3.46	.01997	.000948
176	20	.5804	.0290	....	....	3.10	.01799	.000899
190	18	.4673	.0259	....	....	3.25	.01519	.000842
191	17	.4279	.0251	....	....	3.25	.01091	.000816
192	17	.4126	.0242	....	....	3.12	.01287	.000755
194	13	.3218	.0247	....	....	3.43	.01104	.000847
195	19	.4924	.0259	....	....	3.33	.01640	.000862
198	18	.4683	.0260	....	....	3.18	.01489	.000827
200	18	.5764	.0320	....	....	3.24	.01868	.001040
202	14	.3824	.0273	0.0200	1.3615	3.13	.01197	.000854
203	16	.5251	.0328	.0241	1.3614	3.07	.01612	.001007
206	17	.3392	.0199	.0157	1.2709	3.44	.01166	.000685
208	19	.4939	.0259	.0192	1.3494	3.21	.01585	.000831
213	15	.4116	.0274	.0204	1.3415	3.31	.01362	.000907
214	16	.4371	.0273	.0208	1.3082	3.09	.01351	.000844
216	15	.3122	.0208	.0165	1.2588	3.33	.01040	.000693
220	17	.5040	.0296	.0222	1.3350	3.20	.01613	.000947
223	17	.4795	.0282	.0204	1.3970	3.31	.01587	.000933
226	21	.5380	.0256	.0170	1.4951	3.11	.01673	.000796
228	14	.4143	.0295	.0211	1.3945	3.40	.01409	.001003
231	18	.5888	.0327	.0242	1.3514	3.11	.01831	.001017
232	13	.3825	.0294	.0221	1.3280	3.11	.01190	.000914
233	17	.5331	.0313	.0231	1.3558	3.32	.01663	.001039
234	16	.5201	.0325	.0243	1.3363	3.23	.01680	.001050
236	25	.7451	.0298	.0220	1.3504	3.19	.02377	.000951
243	24	.6349	.0264	.0196	1.3487	3.47	.02203	.000916
244	19	.5839	.0307	.0214	1.4305	3.30	.01927	.001013
249	16	.4415	.0275	.0199	1.3850	3.21	.01417	.000883
250	15	.4514	.0300	.0213	1.4100	3.12	.01408	.000936
251	22	.6190	.0281	.0203	1.3823	3.46	.02142	.000972
255	18	.5948	.0330	.0233	1.4146	3.03	.01802	.001000
256	21	.5277	.0251	.0184	1.3629	3.31	.01747	.000832
258	17	.4703	.0276	.0211	1.3065	3.38	.01590	.000933

TABLE 4.—*Analyses of spikes of wheat, arranged according to nitrogen content of kernels. Crop of 1902*—Continued.

3 TO 3.5 PER CENT PROTEID NITROGEN—Continued.

Record number.	Number of kernels on row of spikelets.	Weight (in grams) of—		Volume of average kernel.	Specific gravity of kernels.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in—	
		Kernels.	Average kernel.				Kernels.	Average kernel.
262	18	0.4604	0.0255	0.0193	1.3216	3.20	0.01473	0.000816
263	18	.5040	.0280	.0197	1.4206	3.24	.01633	.000907
264	18	.4138	.0229	.0169	1.3544	3.37	.01395	.000772
265	18	.4429	.0246	.0189	1.3005	3.30	.01462	.000812
266	19	.5010	.0263	.0187	1.4090	3.11	.01558	.000818
269	17	.4531	.0266	.0209	1.2748	3.21	.01454	.000854
270	20	.5183	.0259	.0191	1.3541	3.37	.01747	.000873
271	14	.3275	.0233	.0177	1.3143	3.39	.01110	.000790
272	15	.3858	.0257	.0190	1.3564	3.14	.01212	.000807
273	18	.4559	.0253	.0178	1.4228	3.39	.01546	.000858
275	18	.4862	.0270	.0197	1.3711	3.33	.01619	.000899
276	15	.3973	.0264	.0191	1.3815	3.15	.01251	.000832
278	15	.4715	.0314	.0226	1.3903	3.12	.01471	.000980
281	21	.6938	.0330	.0241	1.3693	3.26	.02262	.001076
282	18	.4973	.0276	.0200	1.3795	3.02	.01502	.000834
295	19	.5205	.0273	.0201	1.3608	3.06	.01593	.000835
300	19	.4994	.0262	.0188	1.3945	3.07	.01533	.000894
301	16	.5492	.0343	.0249	1.3787	3.09	.01697	.001060
305	13	.3452	.0265	.0197	1.3432	3.07	.01060	.000814
307	20	.4122	.0206	.0140	1.4727	3.19	.01315	.000657
310	18	.4867	.0270	.0198	1.3681	3.16	.01538	.000853
312	15	.4324	.0288	.0210	1.3718	3.49	.01509	.001005
314	15	.4122	.0274	.0201	1.3657	3.16	.01303	.000866
316	17	.4157	.0244	.0178	1.3733	3.36	.01397	.000820
317	17	.4412	.0259	.0193	1.3424	3.43	.01513	.000888
321	18	.5484	.0304	.0207	1.4660	3.43	.01881	.001043
323	17	.4075	.0239	.0177	1.3487	3.43	.01398	.000820
324	17	.4230	.0248	.0180	1.3740	3.19	.01349	.000791
325	17	.5110	.0300	.0220	1.3658	3.46	.01768	.001038
327	16	.4039	.0252	.0191	1.3225	3.45	.01393	.000869
333	16	.4610	.0288	.0206	1.3956	3.26	.01503	.000939
336	13	.3637	.0279	.0198	1.4102	3.36	.01222	.000937
339	16	.3803	.0237	.0171	1.3828	3.33	.01266	.000789
351	15	.3843	.0256	.0186	1.3812	3.32	.01276	.000851
352	15	.4497	.0299	.0217	1.3829	3.05	.01372	.000914
353	16	.4726	.0295	.0211	1.3988	3.11	.01470	.000917
362	19	.5258	.0276	.0201	1.3701	3.03	.01593	.000836
366	17	.4214	.0247	.0185	1.3350	3.17	.01336	.000783
367	20	.5351	.0267	.0197	1.3555	3.37	.01803	.000900
368	19	.3877	.0204	.0151	1.3497	3.06	.01186	.000624
369	19	.5560	.0292	.0214	1.3621	3.34	.01857	.000975
370	17	.4200	.0247	.0180	1.3735	3.09	.01298	.000763
372	17	.4811	.0283	.0206	1.3714	3.31	.01593	.000937
374	17	.5249	.0308	.0218	1.4142	3.15	.01653	.000970
375	18	.5147	.0285	.0203	1.4018	3.41	.01755	.000975
377	14	.3173	.0226	.0174	1.3013	3.47	.01101	.000784
379	18	.5271	.0292	.0213	1.3703	3.09	.01629	.000902
381	13	.3506	.0269	.0199	1.3544	3.45	.01210	.000928
382	19	.5057	.0266	.0194	1.3728	3.23	.01633	.000859
388	19	.5799	.0305	.0221	1.3773	3.05	.01769	.000930
390	19	.4764	.0250	.0181	1.3806	3.22	.01534	.000805
391	18	.4474	.0248	.0182	1.3628	3.26	.01459	.000808
399	12	.3058	.0254	.0188	1.3510	3.10	.00948	.000787
400	20	.5720	.0286	.0206	1.3837	3.35	.01916	.000958
401	16	.3996	.0249	.0183	1.3575	3.37	.01347	.000839
403	17	.5000	.0294	.0211	1.3927	3.04	.01520	.000894
404	18	.4286	.0238	.0180	1.3221	3.30	.01414	.000785
410	20	.5368	.0268			3.27	.01755	.000780
411	14	.3479	.0248			3.15	.01096	.000781
414	19	.5044	.0265			3.14	.01584	.000832
416	15	.4269	.0284			3.24	.01383	.000920
418	21	.4995	.0237			3.05	.01523	.000723
423	18	.4845	.0269			3.14	.01521	.000845
425	16	.4801	.0300			3.30	.01584	.000990
426	18	.5166	.0287			3.09	.01596	.000887
427	19	.5433	.0285			3.06	.01662	.000872
429	20	.4704	.0235			3.04	.01430	.000714
431	18	.4119	.0228			3.20	.01318	.000732
432	21	.6306	.0300			3.00	.01892	.000900
433	20	.5206	.0260			3.12	.01624	.000811
437	16	.4336	.0271			3.13	.01357	.000848
442	17	.3889	.0228			3.23	.01256	.000736
Average	17.4	.4724	.0270	.0199	1.3666	3.23	.01520	.000874

TABLE 4.—*Analyses of spikes of wheat, arranged according to nitrogen content of kernels. Crop of 1902*—Continued.

3.5 TO 4 PER CENT PROTEID NITROGEN.

Record number.	Number of kernels on row of spikelets.	Weight (in grams) of—		Volume of average kernel.	Specific gravity of kernels.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in—	
		Kernels.	Average kernel.				Kernels.	Average kernel.
174	18	0.4025	0.0223			3.76	0.01513	0.000838
177	19	.4073	.0214			3.57	.01454	.000764
179	19	.4972	.0261			3.85	.01914	.001005
180	17	.5262	.0309			3.58	.01884	.001110
184	20	.5512	.0275			3.78	.02084	.001040
186	21	.5414	.0257			3.97	.02149	.001020
204	15	.4015	.0267	0.0198	1.3460	3.90	.01566	.001043
209	17	.3588	.0211	.0164	1.2828	3.82	.01371	.000806
215	12	.3318	.0276	.0205	1.3493	3.79	.01258	.001046
224	17	.4891	.0287	.0220	1.3039	3.65	.01785	.001048
225	19	.4976	.0261	.0193	1.3507	3.55	.01766	.000927
235	18	.4555	.0253	.0192	1.3164	3.65	.01663	.000923
240	16	.3984	.0249	.0177	1.4025	3.53	.01406	.000879
245	15	.3971	.0264	.0200	1.3230	3.64	.01445	.000961
246	18	.4562	.0253	.0194	1.3058	3.75	.01711	.000949
247	18	.4937	.0274	.0202	1.3561	3.50	.01728	.000959
248	17	.4617	.0271	.0193	1.4095	3.65	.01685	.000991
253	21	.5960	.0283	.0203	1.3917	3.63	.02163	.001327
259	19	.4932	.0259	.0193	1.3400	3.84	.01894	.000995
261	17	.5195	.0305	.0229	1.3333	3.50	.01818	.001068
274	15	.3347	.0223	.0168	1.3300	3.57	.01195	.000796
279	16	.4304	.0269	.0200	1.3441	3.79	.01631	.001020
280	16	.4305	.0269	.0198	1.3600	3.70	.01593	.000995
283	17	.4974	.0292	.0210	1.3911	3.86	.01920	.001127
284	14	.3723	.0265	.0189	1.4050	3.72	.01385	.000986
285	18	.5769	.0320	.0233	1.3715	3.87	.02233	.001238
286	17	.4140	.0243	.0178	1.3660	3.56	.01474	.000865
287	16	.4740	.0296	.0223	1.3270	3.87	.01835	.001146
290	16	.3955	.0247	.0177	1.3921	4.00	.01582	.000988
296	17	.5037	.0296	.0214	1.3832	3.94	.01985	.001166
299	17	.4553	.0267	.0195	1.3715	3.68	.01676	.000983
309	18	.4753	.0239	.0239	1.1051	3.75	.01782	.000990
313	17	.4798	.0282	.0202	1.3971	3.52	.01689	.000993
328	20	.5795	.0289	.0215	1.3466	3.61	.02092	.001043
363	17	.3795	.0223	.0165	1.3499	3.50	.01328	.000781
365	16	.3469	.0216	.0169	1.2787	3.50	.01214	.000756
384	14	.4012	.0286	.0212	1.3499	3.56	.01428	.001020
385	15	.4162	.0277	.0203	1.3670	3.79	.01578	.001050
405	18	.4940	.0274	.0203	1.3508	3.76	.01857	.001030
407	20	.4707	.0235	.0171	1.3700	3.79	.01784	.000891
408	19	.4462	.0234			3.64	.01624	.000852
409	17	.4329	.0254			3.59	.01554	.000912
412	16	.3390	.0211			3.63	.01231	.000766
413	17	.4393	.0258			3.77	.01656	.000973
417	19	.4530	.0238			3.80	.01721	.000904
420	17	.4156	.0244			3.73	.01550	.000910
422	23	.5395	.0234			3.53	.01904	.000826
435	20	.4310	.0215			3.53	.01521	.000759
446	17	.4425	.0260			3.75	.01659	.000975
Average	17.3	.4517	.0257	.01987	1.3494	3.70	.01672	.000982

Table 5 shows at a glance the averages for each of the classes of spikes just tabulated, and permits of a comparison of the average figures for each class.[a]

[a] The determinations of specific gravity were made by the following method, devised by Prof. S. Avery: A light basket of wire gauze was suspended by a hair from the hook that supported one of the pan hangers of the balance. The basket was allowed to hang in a beaker of benzol supported by a shelf above the pan. By using a counterpoise the balance was now brought to the zero point. The balance was kept at zero by the occasional adjustment of a rider on the left arm of the beam. The wheat was weighed on the pan of the balance, then transferred to the basket and weighed in benzol, and the temperature of the latter carefully noted. The specific gravity was calculated from the well-known formula:

$$\frac{\text{Wt. in air} \times \text{sp. gr. in benzol at T}^\circ}{\text{Wt. in air} - \text{wt. in benzol}} = \text{Sp. gr.}$$

TABLE 5.—*Summary of analyses of spikes of wheat, arranged according to nitrogen content of kernels. Crop of 1902.*

Range of percentage of proteid nitrogen.	Percentage of proteid nitrogen in kernels.	Number of—		Weight (in grams) of—		Volume of average kernel.	Specific gravity.	Proteid nitrogen (gram) in—	
		Analyses.	Kernels on row of spikelets.	Kernels.	Average kernel.			Kernels.	Average kernel.
2 to 2.5	2.32	18	17	0.4759	0.0266	0.0209	1.374	0.01141	0.000643
2.5 to 3	2.76	82	17.1	.4791	.0279	.0207	1.368	.01332	.000776
3 to 3.5	3.23	107	17.4	.4724	.0270	.0199	1.367	.01520	.000874
3.5 to 4	3.70	49	17.3	.4715	.0257	.0199	1.349	.01672	.000982

From this table it will be seen that with an increase in the percentage of proteid nitrogen the number of kernels on a row of spikelets remains about constant; that in general there were a decrease in the weight of the kernels on a row of spikelets and a slight decrease in the weight of the average kernel; and that the volume of the average kernel decreased, as did the specific gravity.

It may safely be stated that a high percentage of proteid nitrogen was in these spikes associated with a kernel of low specific gravity, light weight, and small relative volume, and, as the spikes were selected for their ripeness and healthy appearance, this relation can not be attributed to immaturity or disease.

The table last referred to shows a decrease in the weight of the kernels on the spike as the percentage of proteid nitrogen increases; but it also shows that in spite of the decrease in the weight of the kernels there is an increase in the actual amount of proteid nitrogen they contain, and that the same is true of the average kernel.

Table 6 gives a summary of the same analyses, arranged according to the specific gravities of the kernels. All spikes whose kernels had a specific gravity below 1.30 are grouped in one class, those having a specific gravity of 1.30 to 1.33 in another class, and so on until finally all spikes having a specific gravity of more than 1.42 form the last class.

TABLE 6.—*Summary of analyses of spikes of wheat, arranged according to specific gravities of kernels. Crop of 1902.*

Range of specific gravity.	Specific gravity of kernels.	Number of—		Weight of kernels (gram).	Percentage of proteid nitrogen in kernels.	Weight of average kernel (gram).	Proteid nitrogen (gram) in—	
		Analyses.	Kernels.				Kernels.	Average kernel.
Below 1.30	1.255	8	16.7	0.3887	3.29	0.02331	0.01280	0.0007662
1.30 to 1.33	1.315	17	16.5	.4315	3.35	.02617	.01446	.0008762
1.33 to 1.36	1.347	50	17.3	.4008	2.91	.02366	.01508	.0008756
1.36 to 1.39	1.375	71	17.2	.4794	3.06	.02786	.01462	.0008559
1.39 to 1.42	1.399	40	16.7	.4848	3.03	.02899	.01459	.0008729
1.42 and over	1.463	8	19.1	.5287	3.07	.02773	.01605	.0008371

This table shows no constant relation between the specific gravity and the number of kernels on the spike. With an increase in the specific gravity there is an increase in the weight of the kernels on the spike, and with some exceptions an increase in the weight of the average kernel. As the specific gravity increases, the percentage of proteid nitrogen decreases, which agrees with the previous table. The grams of proteid nitrogen in the kernels on the spikes and in the average kernel increase with the specific gravity.

Table 7 shows the summary of the same analyses, arranged according to the weight of the average kernel. Spikes whose kernels have an average weight of less than 0.024 gram form the first class, and each succeeding class increases by 0.002 gram.

TABLE 7.—*Summary of analyses of spikes of wheat, arranged according to weight of average kernel. Crop of 1902.*

Range of weight of average kernel (gram).	Weight of average kernel (gram).	Number of—		Weight of kernels (gram).	Specific gravity of kernels.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in—	
		Analyses.	Kernels.				Average kernel.	Kernels.
Below 0.024	0.02214	27	16.9	0.3812	1.341	3.197	0.0007184	0.01215
0.024 to 0.026	.02528	38	17.5	.4425	1.361	3.28	.0008294	.01438
0.026 to 0.028	.02705	48	17.0	.4609	1.360	3.22	.0008711	.01475
0.028 to 0.030	.02896	40	17.0	.4916	1.372	3.11	.0009090	.01546
0.030 to 0.032	.03089	26	17.0	.5274	1.388	2.86	.0008787	.01506
0.032 and over	.03324	19	16.8	.5588	1.373	2.88	.0009594	.01617

There seems to be no relation between the weight of the average kernel and the number of kernels on the spike. The weight of all the kernels on the spike naturally increases with the weight of the average kernel. The specific gravity of the kernels increases with the weight of the average kernel. The percentage of proteid nitrogen decreases with an increase in the weight of the average kernel, in which respect it agrees with the two previous tables. The grams of proteid nitrogen in the average kernel and the total proteid nitrogen in the spike increase with the weight of the average kernel.

Samples from each of the spikes of wheat from which these data were derived were planted, together with samples from other spikes, all of which have been analyzed, aggregating 800 in all. Each kernel was planted separately at a distance of 6 inches each way from every other kernel. The kernels from each spike were marked by a stake bearing the record number of the spike.

During the winter a considerable number of plants were killed, so that the stand was irregular in the spring. In some cases all of the plants resulting from a spike of the previous year were killed, and in other cases only a portion of such plants. The result was a somewhat uneven stand, which doubtless gave certain plants an advantage over others in growth and yield.

When the crop was ripe in 1903 each plant was harvested separately, and all of those resulting from spikes which the previous year had shown a proteid nitrogen content of more than 4 per cent or less than 2 per cent were analyzed, as were also a certain number resulting from spikes of intermediate values.

The good kernels on each plant were counted and weighed, thus giving a record of the yield of each plant. From these data the average weight of the kernels per plant was calculated. The specific gravity was not determined and consequently the average volume of the kernels on each plant was not calculated, as was done the previous year.

In Table 8 the plants harvested in 1903 are arranged in classes of 1 to 2 per cent proteid nitrogen, 2 to 2.5 per cent, 2.5 to 3 per cent, 3 to 3.5 per cent, 3.5 to 4 per cent, 4 to 4.5 per cent, and over 4.5 per cent. The number and weight of the kernels on each plant are stated, as is also the average weight of each kernel. The number of grams of proteid nitrogen in all the kernels of the plant is shown, and also the number of grams of proteid nitrogen in the average kernel on each plant. Table 9 shows the average for each class.

These results, so far as they cover the same ground as those of the previous year, have the same significance. They show a quite uniform although slight decrease in the weight of the average kernel accompanying an increase in the percentage of proteid nitrogen, and a very marked increase in the number of grams of proteid nitrogen in the average kernel. Especially marked is the increase in the amount of proteid nitrogen in the average kernel, amounting to 28 per cent of the weight of the kernel for every 1 per cent increase in the content of proteid nitrogen.

One column of this table, not contained in that compiled from results of the previous year, shows the number of grams of proteid nitrogen contained in all of the kernels on the plant; or, in other words, the proteid nitrogen production of the plant. This appears, on the whole, to increase with the percentage of proteid nitrogen, although the results are not sufficiently consistent to permit of an unqualified statement to that effect. The uneven stand of the plants, before referred to, doubtless accounts for these inconsistent results.

Two other columns contain data not obtained in 1902. The first of these shows the number of kernels per plant, which apparently decreases slightly as the percentage of proteid nitrogen increases, but this can not be stated unqualifiedly. The next column shows the weight of kernels per plant, or the yield per plant, which likewise seems to decrease slightly with an increase in the percentage of proteid nitrogen.

TABLE 8.—*Analyses of plants, arranged according to percentage of proteid nitrogen. Crop of 1903.*

1 TO 2 PER CENT PROTEID NITROGEN.

Record number.	Percentage of proteid nitrogen in kernels.	Number of kernels per plant.	Weight (in grams) of— Kernels per plant.	Weight (in grams) of— Average kernel.	Total proteid nitrogen in all kernels (gram).	Proteid nitrogen in average kernel (gram).
32206	1.81	507	10.4036	0.02052	0.18831	0.0003714
32605	1.20	225	5.2268	.02323	.06272	.0002788
33407	1.62	305	7.0889	.02271	.11223	.0003679
33408	1.39	77	1.1132	.01446	.01547	.0002009
33905	1.61	508	11.1476	.02194	.17948	.0003533
42206	1.46	25	.3161	.01264	.00462	.0001846
45606	1.91	220	4.0358	.01834	.07708	.0003504
45805	1.84	124	1.5298	.01234	.02815	.0002700
48407	1.50	718	11.2890	.01572	.16933	.0002358
51005	1.34	862	15.5935	.01804	.20881	.0002422
55307	1.89	342	5.6864	.01663	.10747	.0003142
57308	1.69	577	9.8378	.01705	.16626	.0002881
57405	1.98	41	.8328	.02031	.01649	.0004022
57607	1.73	736	16.4433	.02234	.24847	.0003865
58806	1.88	95	1.9469	.02049	.03660	.0003853
60605	1.87	35	.5952	.01701	.01113	.0003180
63505	1.90	208	4.0230	.01934	.07644	.0003674
69806	1.66	558	12.0136	.02153	.19943	.0003574
72606	1.89	543	9.3629	.01724	.18538	.0003414
74305	1.98	216	4.4222	.02047	.08756	.0004054
80305	1.81	729	15.7835	.02165	.28569	.0003919
81705	1.98	465	9.7922	.02106	.19388	.0004170
81710	1.92	396	9.1411	.02308	.17550	.0004432
92407	1.66	53	.8983	.01695	.01491	.0002814
94205	1.65	64	1.2117	.01893	.01999	.0003124
94605	1.95	56	.7319	.01307	.01427	.0002549
94908	1.96	125	2.3678	.01894	.04641	.0003713
95510	1.81	159	2.8356	.01783	.05132	.0003228
Average	1.749	320.3	6.23823	.01871	.10655	.00032914

2 TO 2.5 PER CENT PROTEID NITROGEN.

17405	2.13	738	15.6996	0.02127	0.33441	0.0004531
17408	2.18	497	9.2038	.01852	.20065	.0004037
18805	2.02	137	2.1462	.01567	.04335	.0003164
21212	2.16	84	1.7216	.02050	.03718	.0004427
21705	2.45	58	1.5420	.02659	.03778	.0006514
21707	2.19	582	12.3685	.02125	.27086	.0004654
21708	2.33	390	9.2850	.02381	.21634	.0005547
21709	2.47	361	7.7296	.02141	.19092	.0005289
21912	2.31	510	9.7236	.01907	.22461	.0004404
27205	2.41	891	16.4061	.01841	.39539	.0004437
27206	2.36	777	19.1854	.02469	.45276	.0005827
27306	2.47	684	13.3011	.01945	.32853	.0004803
27505	2.12	539	12.0399	.02183	.24942	.0004627
33107	2.35	318	6.1026	.01919	.14341	.0004510
33405	2.03	421	8.1268	.01930	.16498	.0003919
33605	2.39	301	7.0596	.02345	.16872	.0005605
33606	2.21	382	8.1890	.02144	.18098	.0004738
34208	2.13	156	2.9886	.01916	.06366	.0004081
37706	2.34	56	1.2069	.02155	.02824	.0005053
37906	2.44	19	.2063	.01086	.00503	.0002649
39205	2.11	1,031	21.5399	.02089	.45435	.0004407
39606	2.37	346	4.6383	.01341	.10967	.0003177
44607	2.44	101	1.8246	.01806	.04452	.0004408
48106	2.38	608	11.6655	.01919	.27765	.0004567
48409	2.02	314	6.4302	.02048	.12989	.0004137
55305	2.48	167	2.5160	.01507	.06240	.0003736
55306	2.18	214	4.1323	.01931	.09008	.0004210
55608	2.31	837	22.5848	.02699	.52194	.0006236
55908	2.42	562	12.2210	.02175	.29575	.0005262
55909	2.30	302	9.2120	.03050	.21187	.0007016
56206	2.42	509	9.3093	.01829	.22529	.0004426
56207	2.34	462	10.9073	.02361	.25522	.0005524
57307	2.43	261	4.7117	.01801	.11445	.0004387
57508	2.21	380	12.0728	.03177	.26680	.0007021
58905	2.43	170	2.3031	.01355	.05596	.0003292
59605	2.12	382	7.1828	.01880	.15228	.0003986
59606	2.16	567	9.7084	.01712	.20970	.0003698
63107	2.43	417	9.3120	.02233	.22628	.0005426

TABLE 8.—*Analyses of plants, arranged according to percentage of proteid nitrogen. Crop of 1903*—Continued.

2 TO 2.5 PER CENT PROTEID NITROGEN—Continued.

Record number.	Percentage of proteid nitrogen in kernels.	Number of kernels per plant.	Weight (in grams) of— Kernels per plant.	Weight (in grams) of— Average kernel.	Total proteid nitrogen in all kernels (gram).	Proteid nitrogen in average kernel (gram).
63506	2.44	153	2.3986	.01568	0.05853	0.0003825
65306	2.41	544	9.8298	.01807	.23690	.0004355
65307	2.28	373	7.0051	.01878	.15971	.0004282
65308	2.09	583	11.7066	.02008	.24468	.0004197
69505	2.29	225	4.7116	.01847	.10790	.0004231
71905	2.47	1,260	28.2136	.02239	.69688	.0005531
72705	2.13	372	9.1522	.02191	.19936	.0004668
72708	2.27	398	9.0386	.02270	.20518	.0005154
72905	2.48	167	2.6462	.01585	.06563	.0003930
73306	2.45	414	8.5373	.02062	.20918	.0005052
73307	2.39	25	.5572	.02229	.01332	.0005327
74606	2.30	464	9.6451	.02079	.22184	.0004781
76205	2.35	498	8.4407	.01695	.19836	.0003983
81707	2.34	786	18.3614	.02336	.42965	.0005466
81708	2.41	287	7.3993	.02578	.17833	.0006213
81709	2.28	757	16.4692	.02175	.37548	.0004960
84405	2.48	428	8.7448	.02043	.21687	.0005067
84905	2.32	37	.7130	.01927	.01654	.0004471
88608	2.47	74	1.5355	.02075	.03793	.0005125
88609	2.42	470	9.8719	.02100	.23890	.0005082
92409	2.30	315	5.7131	.01814	.13140	.0004171
94209	2.49	190	3.6006	.01895	.08965	.0004719
94406	2.47	549	10.5556	.01923	.26073	.0004749
94407	2.07	419	6.7664	.01615	.14007	.0003343
94905	2.35	286	4.4423	.01553	.10439	.0003650
95509	2.48	138	2.9475	.02136	.07310	.0005297
95707	2.47	52	.7577	.01457	.01872	.0003599
Average	2.319	396.8	8.2502	.020113	.190316	.0004660

2.5 TO 3 PER CENT PROTEID NITROGEN.

Record number.	Percentage of proteid nitrogen in kernels.	Number of kernels per plant.	Weight (in grams) of— Kernels per plant.	Weight (in grams) of— Average kernel.	Total proteid nitrogen in all kernels (gram).	Proteid nitrogen in average kernel (gram).
17409	2.75	802	14.8957	0.01857	0.40964	0.0005108
17410	2.88	744	16.9987	.02285	.48957	.0006580
20706	2.78	163	3.3138	.02033	.09212	.0005652
20707	2.77	444	9.9070	.02282	.27443	.0006181
20708	2.58	122	2.4690	.02024	.06399	.0005221
20710	2.83	867	17.1115	.01974	.48428	.0005586
21207	2.96	118	2.3066	.01955	.06804	.0005766
21305	2.67	312	6.2514	.02004	.16691	.0005350
21306	2.90	226	4.1516	.01837	.12039	.0005327
21710	2.59	59	.8478	.01437	.02196	.0003722
21711	2.71	873	17.1820	.01968	.46563	.0005334
21805	2.69	1,232	20.9290	.01699	.56299	.0004569
21806	2.71	599	14.2450	.02378	.38604	.0006444
21807	2.73	377	9.4172	.02498	.25709	.0006664
21808	2.57	1,156	19.7446	.01708	.50744	.0004389
21809	2.73	418	8.0214	.01919	.21898	.0005238
21810	2.69	52	1.0304	.01982	.02772	.0005330
21905	2.64	791	14.3111	.01809	.37781	.0004777
22205	2.81	283	2.6965	.00953	.07577	.0002677
22207	2.77	169	3.2787	.01940	.09082	.0005374
25205	2.71	522	10.7836	.02066	.28560	.0005599
25206	2.76	205	4.6754	.02281	.12904	.0006295
26106	2.63	90	2.0737	.02304	.05454	.0006060
26805	2.81	220	4.9456	.02248	.13897	.0006317
26806	2.60	152	2.7255	.01793	.07086	.0004662
26807	2.80	721	17.2324	.02390	.48250	.0006692
26905	2.76	326	6.4102	.01966	.17692	.0005427
26906	2.71	228	4.2376	.01859	.11484	.0005037
26907	2.61	102	1.8276	.01792	.04995	.0004677
26908	2.96	192	3.9797	.02073	.11780	.0006135
26909	2.80	180	2.9999	.01667	.08400	.0004667
27005	2.63	866	16.4120	.01895	.43164	.0004984
27207	2.92	166	3.3266	.02004	.09712	.0005850
27305	2.58	267	5.5666	.02085	.14362	.0005379
27307	2.53	167	3.0850	.01847	.07805	.0004674
27506	2.70	444	10.0005	.02252	.27003	.0006082
27508	2.64	251	5.5324	.02287	.14608	.0006037
27509	2.90	243	5.3615	.02206	.15549	.0006399
28805	2.91	87	2.1851	.02512	.06359	.0007309
32606	2.88	94	2.0162	.02145	.05807	.0006177

TABLE 8.—*Analyses of plants, arranged according to percentage of proteid nitrogen. Crop of 1903*—Continued.

2.5 TO 3 PER CENT PROTEID NITROGEN—Continued.

Record number.	Percentage of proteid nitrogen in kernels.	Number of kernels per plant.	Weight (in grams) of— Kernels per plant.	Weight (in grams) of— Average kernel.	Total proteid nitrogen in all kernels (gram).	Proteid nitrogen in average kernel (gram).
33105	2.91	132	2.5601	0.01939	0.07450	0.0005644
33106	2.94	18	.3089	.01716	.00908	.0005045
33406	2.87	283	4.6045	.01627	.13215	.0004670
33906	2.81	119	2.2862	.01921	.06424	.0005399
34205	2.73	464	9.1498	.01972	.24979	.0005383
34207	2.84	611	13.5556	.02219	.38505	.0006273
37305	2.96	309	6.1394	.01987	.18173	.0005881
37705	2.64	461	8.0905	.01972	.23998	.0005327
37707	2.94	193	3.3004	.01710	.09670	.0005010
37905	2.53	37	.9452	.02555	.02391	.0006463
38005	2.84	139	2.5134	.01808	.07138	.0005135
38506	2.89	85	1.6799	.01975	.04855	.0005712
38606	2.63	401	8.4605	.02110	.22251	.0005549
38608	2.82	158	3.0228	.01913	.08522	.0005394
38609	2.74	293	6.7665	.02309	.18540	.0006475
38706	2.59	365	7.2545	.01988	.18789	.0005148
39405	2.88	447	9.3541	.02093	.21399	.0006027
39506	2.93	67	1.9218	.02869	.05631	.0008404
40505	2.82	170	4.1546	.02444	.11716	.0006892
43405	2.92	124	2.8000	.02258	.08176	.0006594
44505	2.94	340	5.9990	.01764	.17637	.0005187
44605	2.86	55	1.1271	.02049	.03223	.0005861
44606	2.90	124	2.5235	.02035	.07318	.0005902
45605	2.82	61	.7081	.01161	.01997	.0003273
46106	2.54	82	1.6103	.01964	.04090	.0004988
46107	2.54	478	8.3935	.01756	.21319	.0004460
48305	2.87	473	12.0278	.02543	.34524	.0007299
48408	2.81	27	.3485	.01291	.00979	.0003627
48507	2.64	70	1.6036	.02296	.04233	.0006062
48508	2.76	603	11.2008	.01858	.30986	.0005127
48806	2.70	547	9.8346	.01798	.26553	.0004877
50706	2.80	35	.4701	.01343	.01316	.0003761
55008	2.60	944	17.4226	.01846	.45299	.0004799
55206	2.56	578	11.3592	.01965	.29079	.0005031
55308	2.54	397	9.5078	.02395	.24150	.0006225
55506	2.80	866	17.8506	.02062	.49995	.0005773
55507	2.63	504	9.8228	.01949	.25834	.0005126
55605	2.64	500	10.9180	.02184	.28823	.0005765
55606	2.58	503	11.0930	.02205	.28580	.0005690
55607	2.69	138	2.3931	.01734	.06437	.0004665
55905	2.67	331	5.7948	.01751	.15470	.0004674
55906	2.81	499	7.9968	.01603	.22471	.0004503
55907	2.59	749	19.3966	.02590	.50238	.0006707
56105	2.73	336	5.7431	.01709	.15679	.0004667
56106	2.57	644	12.0161	.01866	.30881	.0004795
56107	2.96	872	14.4556	.01658	.42790	.0004907
56205	2.51	333	6.5232	.01959	.16373	.0004917
56208	2.61	563	13.5720	.02356	.34616	.0006149
56209	2.59	950	15.8086	.01664	.40945	.0004310
57005	2.71	88	1.5364	.01746	.04164	.0004731
57006	2.76	701	10.1836	.01453	.28107	.0004010
57007	2.65	168	3.3176	.01975	.08792	.0005233
57105	2.76	407	3.7263	.00916	.10285	.0002527
57306	2.86	434	7.9772	.01838	.22815	.0005257
57406	2.75	135	2.4923	.01846	.06854	.0005077
57407	2.62	762	14.9992	.01968	.39297	.0005157
57408	2.61	596	12.2004	.02047	.31842	.0005343
57506	2.80	180	2.7616	.01534	.07733	.0004296
57507	2.85	359	6.9861	.01946	.19905	.0005545
57509	2.54	611	10.6261	.01739	.26990	.0004417
57606	2.74	132	3.0790	.02333	.08436	.0006391
57608	2.64	438	8.6189	.01968	.22756	.0005195
57805	2.87	270	4.8988	.01814	.14060	.0005207
58206	2.67	148	1.3961	.00943	.03728	.0002519
58505	2.95	273	7.4516	.02730	.21982	.0008052
58805	2.74	1,158	23.1471	.01999	.63422	.0005464
63106	2.79	165	3.3006	.02001	.09208	.0005581
66005	2.63	370	7.6690	.02073	.20170	.0005451
69506	2.50	663	13.5696	.02047	.33923	.0005117
69705	2.50	244	3.7810	.01550	.09453	.0003874
72406	2.95	430	8.2929	.01929	.24464	.0005689
73308	2.92	624	14.2986	.02291	.41752	.0006539
74506	2.73	23	.4096	.01781	.01118	.0004862
74508	2.60	57	.8172	.01434	.02125	.0003728
74605	2.60	399	7.1181	.01784	.18507	.0004638

TABLE 8.—*Analyses of plants, arranged according to percentage of proteid nitrogen. Crop of 1903*—Continued.

2.5 TO 3 PER CENT PROTEID NITROGEN—Continued.

Record number.	Percentage of proteid nitrogen in kernels.	Number of kernels per plant.	Weight (in grams) of—		Total proteid nitrogen in all kernels (gram).	Proteid nitrogen in average kernel (gram).
			Kernels per plant.	Average kernel.		
74607	2.56	491	8.3406	0.01699	0.21352	0.0004349
81405	2.62	240	4.5737	.01862	.11710	.0004879
81505	2.94	146	2.8327	.01940	.08328	.0005704
81706	2.71	722	15.3928	.02132	.41715	.0005778
85205	2.60	214	3.4766	.01625	.09039	.0004224
85206	2.66	376	4.9315	.01312	.13118	.0003332
86105	2.56	203	3.0282	.01495	.07964	.0003923
86106	2.63	436	7.6241	.01749	.20052	.0004599
88605	2.80	69	1.6362	.02731	.04581	.0007640
88606	2.53	481	9.9456	.02068	.25162	.0005231
88607	2.61	234	5.1584	.02205	.13463	.0005754
88905	2.83	293	5.3069	.01811	.15019	.0005126
88906	2.65	546	9.9034	.01814	.26245	.0004807
91906	2.81	200	3.5486	.01774	.09972	.0004986
92205	2.74	345	5.2616	.01525	.14417	.0004179
92206	2.67	46	1.1074	.02407	.02957	.0006428
92207	2.55	209	3.6926	.01767	.09416	.0004505
92208	2.72	353	6.6206	.01876	.18008	.0005102
92305	2.93	160	2.3859	.01491	.06991	.0004369
92408	2.97	207	3.7820	.01827	.11233	.0005426
92507	2.58	505	9.6779	.01916	.24969	.0004944
94206	2.78	402	7.5006	.01866	.20851	.0005187
94207	2.86	718	13.7057	.01909	.39199	.0005460
94907	2.94	626	12.1918	.01948	.35844	.0005726
95505	2.81	37	.3146	.00850	.00884	.0002389
95506	2.74	597	11.0548	.01852	.30291	.0005074
95507	2.59	571	12.1592	.02030	.31492	.0005515
95508	2.56	740	14.4617	.01954	.37023	.0005003
95705	2.54	636	10.3426	.01626	.26270	.0004131
95706	2.73	267	5.1629	.01934	.14095	.0005279
Average	2.731	370.36	7.1755	.019354	.194423	.00052706

3 TO 3.5 PER CENT PROTEID NITROGEN.

17305	3.03	183	3.6302	0.01984	0.10999	0.0006010
17306	3.09	243	3.9968	.01645	.12350	.0005082
17307	3.46	138	3.1454	.02280	.10883	.0007886
17308	3.25	61	1.2275	.02012	.03994	.0006540
17406	3.29	124	2.0907	.01683	.06878	.0005547
18906	3.48	65	.9229	.01420	.03212	.0004941
20705	3.09	109	1.8517	.01698	.05722	.0005249
20709	3.05	258	5.3229	.02063	.16235	.0006292
20805	3.32	697	14.6942	.02157	.48784	.0006999
21205	3.16	123	2.3642	.01922	.07471	.0006074
21208	3.24	287	5.1594	.01798	.16712	.0005824
21211	3.15	10	.2806	.02806	.00884	.0008839
21307	3.04	143	2.5691	.01796	.07810	.0005461
21308	3.45	354	5.8080	.01641	.20038	.0005660
21906	3.18	408	10.4800	.02563	.33403	.0008168
21907	3.35	158	2.9248	.01851	.09798	.0006201
21913	3.01	492	10.1925	.02072	.30680	.0006235
22206	3.22	146	2.5712	.01720	.08086	.0005538
22208	3.18	118	1.9090	.01619	.06071	.0005144
22210	3.17	298	6.0173	.02019	.19075	.0006401
22211	3.17	561	11.5675	.02062	.36671	.0006537
26105	3.02	131	1.8242	.01393	.05508	.0003662
26808	3.09	222	3.8811	.01748	.11992	.0005402
27507	3.08	75	1.3746	.01833	.04234	.0005646
28206	3.07	219	4.3698	.01996	.13415	.0006126
28806	3.02	685	14.4630	.02111	.43679	.0006376
32207	3.48	69	1.2573	.01822	.04375	.0006341
33305	3.41	150	3.1346	.02090	.10689	.0007126
33607	3.22	136	2.8903	.02125	.09307	.0006843
34606	3.12	280	6.1962	.02213	.19332	.0006904
39507	3.02	111	1.8862	.01699	.05696	.0005132
40305	3.11	179	3.6003	.02011	.11197	.0006255
40405	3.17	46	.6316	.01373	.02002	.0004352
42405	3.07	66	1.4892	.02251	.04572	.0006927
42905	3.17	67	1.2499	.01866	.03650	.0005447
46105	3.00	260	4.6146	.01775	.13843	.0005324
48306	3.29	157	2.6571	.01692	.08742	.0005568

TABLE 8.—*Analyses of plants, arranged according to percentage of proteid nitrogen. Crop of 1903*—Continued.

3 TO 3.5 PER CENT PROTEID NITROGEN—Continued.

Record number.	Percentage of proteid nitrogen in kernels.	Number of kernels per plant.	Weight (in grams) of—		Total proteid nitrogen in all kernels (gram).	Proteid nitrogen in average kernel (gram).
			Kernels per plant.	Average kernel.		
48405	3.31	76	0.9701	0.01276	0.03211	0.0004225
48506	3.20	556	9.4585	.01701	.30267	.0005444
48705	3.13	264	4.3615	.01652	.13652	.0005171
48706	3.00	379	6.1986	.01635	.18596	.0004906
49505	3.24	67	1.2716	.01898	.04120	.0006149
50905	3.30	221	2.3982	.01085	.07914	.0003581
55005	3.05	393	7.9684	.02028	.24304	.0006185
55006	3.16	451	7.1852	.01593	.22705	.0005034
55205	3.10	40	.6893	.01723	.02137	.0005342
55508	3.11	216	3.7407	.01732	.11636	.0005386
57305	3.19	501	8.5777	.01666	.29188	.0005326
57905	3.18	221	2.4731	.01118	.07859	.0003556
58207	3.09	307	4.2207	.01375	.13042	.0004248
58705	3.01	235	2.5436	.01082	.07656	.0003256
62805	3.25	111	1.3451	.01212	.04272	.0003938
63105	3.24	90	1.5452	.01717	.05007	.0005563
72405	3.36	213	8.4415	.03963	.28363	.0013316
72707	3.49	225	4.5806	.02036	.15986	.0007105
72806	3.01	110	2.0970	.01906	.06312	.0005738
74507	3.02	493	9.2130	.01869	.27823	.0005644
81406	3.31	72	1.2391	.01721	.04101	.0005697
84906	3.43	382	7.5438	.01975	.25873	.0006773
91305	3.21	138	3.0940	.02242	.09932	.0007197
91905	3.36	198	3.4436	.01739	.11570	.0005844
92405	3.10	214	3.4356	.01605	.10650	.0004977
92406	3.11	380	8.2366	.02168	.25616	.0006741
92505	3.00	156	2.6615	.01706	.07985	.0005118
94208	3.10	322	3.7828	.01175	.11727	.0003642
94906	3.41	685	12.3862	.01808	.42236	.0006166
Average	3.184	235.5	4.38558	.018366	.139656	.00058156

3.5 TO 4 PER CENT PROTEID NITROGEN.

17506	3.52	93	2.2881	0.02460	0.08044	0.0008660
17507	3.80	43	.7220	.01795	.02933	.0006822
18905	3.81	103	1.4864	.01443	.05663	.0005498
21209	3.61	89	1.4484	.01627	.05228	.0005875
21811	3.75	567	11.9114	.02101	.44666	.0007877
21908	3.82	173	3.5574	.02056	.13589	.0007855
22209	3.84	31	.4336	.01399	.01665	.0005371
26107	3.92	144	2.0390	.01416	.07993	.0005551
32608	3.78	55	1.0183	.01851	.03849	.0006998
34206	3.73	81	1.5940	.01968	.05946	.0007340
36905	3.88	267	5.0200	.01880	.19478	.0007295
38505	3.61	563	12.1088	.02252	.43713	.0007764
42205	3.63	94	1.8494	.01967	.06713	.0007142
45005	3.58	235	3.2340	.01376	.11575	.0004927
48505	3.66	137	1.9154	.01398	.07010	.0005117
49905	3.62	23	.6760	.02939	.02436	.0010640
50705	3.54	30	.5958	.01986	.02109	.0007032
50906	3.57	114	1.7280	.01516	.06169	.0005411
66006	3.54	366	6.0090	.01642	.21272	.0005812
66008	3.59	174	3.1555	.01814	.11328	.0006510
72706	3.86	591	14.6802	.02484	.56666	.0009588
94909	3.60	218	3.6977	.01696	.13312	.0006106
Average	3.69	190.5	3.68947	.018666	.13698	.00068723

TABLE 8.—*Analyses of plants, arranged according to percentage of proteid nitrogen. Crop of 1903*—Continued.

4 TO 4.5 PER CENT PROTEID NITROGEN.

Record number.	Percentage of proteid nitrogen in kernels.	Number of kernels per plant.	Weight (in grams) of— Kernels per plant.	Weight (in grams) of— Average kernel.	Total proteid nitrogen in all kernels (gram).	Proteid nitrogen in average kernel (gram).
21812	4.26	983	14.8139	0.01507	0.63107	0.0006420
21813	4.04	216	4.0258	.01877	.16377	.0007582
21909	4.43	525	12.1819	.02317	.53889	.0010265
27308	4.15	254	4.5123	.01777	.18726	.0007373
34405	4.33	207	4.1281	.01994	.17875	.0008635
43505	4.13	93	1.4464	.01555	.05974	.0006423
45705	4.18	44	.7532	.01712	.03148	.0007155
55007	4.21	118	2.1571	.01828	.09082	.0007696
69305	4.42	103	2.0430	.01984	.09030	.0008767
76206	4.45	447	5.4411	.01217	.24213	.0005417
92506	4.39	229	3.8709	.01690	.16993	.0007421
Average	4.27	292.6	5.03397	.017689	.21674	.00075594

MORE THAN 4.5 PER CENT PROTEID NITROGEN

17505	4.70	29	0.3885	0.01340	0.01826	0.0006296
21206	5.23	149	2.8564	.01917	.14939	.0010026
21210	5.03	237	3.9143	.01578	.19689	.0007934
21706	4.71	807	19.3318	.02390	.91052	.0011283
21911	5.48	383	8.4593	.02209	.46356	.0012103
38605	5.85	61	1.2124	.01988	.07093	.0011627
38607	4.55	19	.3037	.01598	.01382	.0007273
40205	4.69	194	3.6302	.01871	.17026	.0008776
48406	4.87	249	3.2964	.01324	.16053	.0006447
65305	4.92	78	1.8018	.02310	.08865	.0011365
69805	5.82	110	2.4420	.02220	.14213	.0012921
72605	4.65	65	1.1166	.01718	.05192	.0007988
72607	5.59	188	3.4442	.01832	.19253	.0010241
92306	4.93	347	6.0091	.01732	.29625	.0008539
Average	5.07	208.28	4.15727	.01859	.208974	.0009487

TABLE 9.—*Summary of analyses of plants, arranged according to percentage of proteid nitrogen. Crop of 1903.*

Range of percentage of proteid nitrogen.	Percentage of proteid nitrogen in kernels.	Number of— Analyses.	Number of— Kernels.	Weight (in grams) of— Kernels.	Weight (in grams) of— Average kernel.	Proteid nitrogen (in grams) in— All kernels.	Proteid nitrogen (in grams) in— Average kernel.
1 to 2	1.749	28	320.3	6.2382	0.01871	0.10655	0.0003291
2 to 2.5	2.32	65	396	8.2502	.02011	.19032	.0004660
2.5 to 3	2.73	145	370	7.1755	.01935	.19442	.0005271
3 to 3.5	3.18	66	235	4.3856	.01837	.13966	.0005816
3.5 to 4	3.69	22	190	3.6895	.01867	.13698	.0006872
4 to 4.5	4.27	11	292	5.0340	.01769	.21674	.0007559
4.5 and over	5.07	14	208	4.1573	.01859	.20897	.0009487

Table 10 shows the analyses of the crop of 1903 arranged on the basis of weight of average kernel. Determinations of gliadin and glutenin were made in these analyses and the sums of these are inserted in this table.[a] All plants having an average kernel weight

[a] Determinations of gliadin and glutenin were made by methods practically the same as those described by Prof. Harry Snyder in Bulletin No. 63 of the Minnesota Experiment Station, except that smaller quantities were used.

of less than 0.010 gram form the first class and each succeeding class increases by 0.002 gram. Table 11 is a summary of these analyses.

TABLE 10.—*Analyses of plants, arranged according to weight of average kernel. Crop of 1903.*

Record number.	Weight of average kernel (gram).	Number of kernels on plant.	Weight of kernels on plant (grams).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in—		Percentage of gliadin-plus-glutenin nitrogen in kernels.	Gliadin-plus-glutenin nitrogen (gram) in—	
					Average kernel.	Kernels on plant.		Average kernel.	Kernels on plant.
WEIGHT OF AVERAGE KERNEL, 0.000 TO 0.010 GRAM.									
22205.....	0.00953	283	2.6965	2.81	0.0002677	0.07577	1.97	0.0001877	0.05312
57105.....	.00916	407	3.7263	2.76	.0002527	.10285			
58206.....	.00943	148	1.3961	2.67	.0002519	.03728			
95505.....	.00850	37	.3146	2.81	.0002389	.00884			
Average .	.00915	219	2.0334	2.76	.0002528	.05618	1.97	.0001877	.05312
WEIGHT OF AVERAGE KERNEL, 0.010 TO 0.012 GRAM.									
37906.....	0.01086	19	0.2063	2.44	0.0002649	0.00503			
45605.....	.01161	61	.7081	2.82	.0003273	.01997			
50905.....	.01085	221	2.3982	3.30	.0003581	.07914			
57905.....	.01118	221	2.4731	3.18	.0003556	.07859	2.92	0.0003264	0.07221
58705.....	.01082	235	2.5436	3.01	.0003258	.07656	2.47	.0002673	.06283
94208.....	.01175	322	3.7828	3.10	.0003642	.11727			
Average .	.01118	179	2.0187	2.98	.0003326	.06276	2.69	.0002968	.06752
WEIGHT OF AVERAGE KERNEL, 0.012 TO 0.014 GRAM.									
17505.....	0.01340	29	0.3885	4.70	0.0006296	0.01826			
22209.....	.01399	31	.4336	3.84	.0005371	.01665			
26105.....	.01393	131	1.8242	3.02	.0003662	.05508			
39606.....	.01341	346	4.6383	2.37	.0003177	.10967			
40405.....	.01373	46	.6316	3.17	.0004352	.02002			
42206.....	.01264	25	.3161	1.46	.0001846	.00462			
45005.....	.01376	235	3.2340	3.58	.0004927	.11575	1.36	0.0001871	0.04398
45805.....	.01234	124	1.5298	1.84	.0002700	.02815			
48405.....	.01276	76	.9701	3.31	.0004225	.03211			
48406.....	.01324	249	3.2964	4.87	.0006447	.16053	2.25	.0002979	.08168
48408.....	.01291	27	.3485	2.81	.0003627	.00979			
48505.....	.01398	137	1.9154	3.66	.0005117	.07010	1.76	.0002460	.03371
50706.....	.01343	35	.4701	2.80	.0003761	.01316			
58207.....	.01375	307	4.2207	3.09	.0004248	.13042	2.49	.0003424	.10510
58905.....	.01355	170	2.3031	2.43	.0003292	.05596			
62805.....	.01212	111	1.3451	3.25	.0003938	.04272			
76206.....	.01217	447	5.4411	4.45	.0005417	.24213	2.03	.0002471	.11046
85206.....	.01312	376	4.9315	2.66	.0003332	.13118			
94605.....	.01307	56	.7319	1.95	.0002549	.01427			
Average .	.01323	155.7	2.0510	3.12	.0004120	.06687	1.98	.0002641	.07499
WEIGHT OF AVERAGE KERNEL, 0.014 TO 0.016 GRAM.									
18805.....	0.01567	137	2.1462	2.02	0.0003164	0.04335			
18905.....	.01443	103	1.4864	3.81	.0005498	.05663	1.54	0.0003218	0.03315
18906.....	.01420	65	.9229	3.48	.0004941	.03212			
21210.....	.01577	237	3.9143	5.03	.0007934	.19689	1.34	.0002113	.05245
21710.....	.01437	59	.8478	2.59	.0003722	.02196			
21812.....	.01507	983	14.8139	4.26	.0006420	.63107	2.02	.0003044	.29934
26107.....	.01416	144	2.0390	3.92	.0005551	.07993	1.35	.0001912	.02753
33408.....	.01446	77	1.1132	1.39	.0002009	.01547			
38607.....	.01598	19	.3037	4.55	.0007273	.01382			
43505.....	.01555	93	1.4464	4.13	.0006423	.05974			
48407.....	.01572	718	11.2890	1.50	.0002358	.16933			
50906.....	.01516	114	1.7280	3.57	.0005411	.06169			
55006.....	.01593	451	7.1852	3.16	.0005034	.22705	1.75	.0002788	.12574
55305.....	.01507	167	2.5160	2.48	.0003736	.06240	1.97	.0002969	.04957
57006.....	.01453	701	10.1836	2.76	.0004010	.28107			

TABLE 10.—*Analyses of plants, arranged according to weight of average kernel. Crop of 1903*—Continued.

WEIGHT OF AVERAGE KERNEL, 0.014 TO 0.016 GRAM—Continued.

Record number.	Weight of average kernel (gram).	Number of kernels on plant.	Weight of kernels on plant (grams).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in—		Percentage of gliadin-plus-glutenin nitrogen in kernels.	Gliadin-plus-glutenin nitrogen (gram) in—	
					Average kernel.	Kernels on plant.		Average kernel.	Kernels on plant.
57506	0.01534	180	2.7616	2.80	0.0004296	0.07733	2.34	0.0003590	0.06462
63506	.01568	153	2.3986	2.44	.0003825	.05853			
69705	.01550	244	3.7810	2.50	.0003874	.09453			
72905	.01585	167	2.6462	2.48	.0003930	.06563			
74508	.01434	57	.8172	2.60	.0003728	.02125			
86105	.01495	203	3.0282	2.56	.0003923	.07964			
92205	.01525	345	5.2616	2.74	.0004179	.14417			
92305	.01491	160	2.3859	2.93	.0004369	.06991			
92905	.01534	176	2.7000	3.50	.0005369	.09450			
92906	.01592	181	2.8816	2.99	.0004760	.08616			
94905	.01553	286	4.4423	2.35	.0003650	.10439			
95707	.01457	52	.7577	2.47	.0003599	.01872			
Average	.01516	232	3.5480	3.00	.0004555	.10619	1.76	.0002805	.09320

WEIGHT OF AVERAGE KERNEL, 0.016 TO 0.018 GRAM.

Record number.	Weight of average kernel (gram).	Number of kernels on plant.	Weight of kernels on plant (grams).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in average kernel.	Proteid nitrogen in kernels on plant.	Percentage of gliadin-plus-glutenin nitrogen in kernels.	Gliadin-plus-glutenin nitrogen in average kernel.	Gliadin-plus-glutenin nitrogen in kernels on plant.
17306	0.01645	243	3.9968	3.09	0.0005082	0.12350			
17406	.01686	124	2.0907	3.29	.0005547	.06878			
17507	.01795	43	.7720	3.80	.0006822	.02934			
20705	.01698	109	1.8517	3.09	.0005249	.05722			
21208	.01798	287	5.1594	3.24	.0005824	.16712	2.15	0.00038[illegible]6	0.11093
21209	.01627	89	1.4484	3.61	.0005875	.05228			
21307	.01796	143	2.5691	3.04	.0005461	.07810			
21308	.01641	354	5.8080	3.45	.0005660	.20038			
21805	.01699	1,232	20.9290	2.69	.0004569	.56299			
21808	.01708	1,156	19.7446	2.57	.0004389	.50744	1.96	.0003348	.38700
22206	.01720	146	2.5712	3.22	.0005538	.08086	2.11	.0003629	.05425
22208	.01619	118	1.9090	3.18	.0005144	.06071	2.14	.0003465	.04084
26806	.01793	152	2.7255	2.60	.0004662	.07086			
26808	.01748	222	3.8811	3.09	.0005402	.11992	2.28	.0003935	.08849
26907	.01792	102	1.8276	2.61	.0004677	.04995			
26909	.01667	180	2.9999	2.80	.0004667	.08400	1.88	.0003134	.05640
27308	.01777	254	4.5123	4.15	.0007373	.18726			
33106	.01716	18	.3089	2.94	.0005045	.00908			
33406	.01627	283	4.6045	2.87	.0004670	.13215			
37707	.01710	193	3.3004	2.93	.0005010	.09670	2.10	.0003591	.0[illegible]931
39507	.01699	111	1.8862	3.02	.0005132	.05696			
44505	.01764	340	5.9990	2.94	.0005187	.17637			
45705	.01712	44	.7532	4.18	.0007155	.03148			
46105	.01775	260	4.6146	3.00	.0005324	.13843			
46107	.01756	478	8.3935	2.54	.0004460	.21319	2.08	.0003652	.17458
48306	.01692	157	2.6571	3.29	.0005568	.08742	2.13	.0003604	.05660
48506	.01701	556	9.4585	3.20	.0005444	.30267	2.17	.0003691	.20525
48705	.01652	264	4.3615	3.13	.0005171	.13652	1.56	.0002577	.06804
48706	.01635	379	6.1986	3.00	.0004906	.18596			
48806	.01798	547	9.8346	2.70	.0004877	.26553			
55205	.01723	40	.6893	3.10	.0005342	.02137			
55307	.01663	342	5.6864	1.89	.0003142	.10747	1.56	.0002594	.08871
55508	.01732	216	3.7407	3.11	.0005386	.11636	1.96	.0003395	.07332
55607	.01734	138	2.3931	2.69	.0004665	.06437			
55905	.01751	331	5.7948	2.67	.0004674	.15470	1.75	.0003064	.10141
55906	.01603	499	7.9968	2.81	.0004503	.22471	1.47	.0002356	.11755
56105	.01709	336	5.7431	2.73	.0004667	.15679	2.12	.0003622	.12175
56107	.01658	872	14.4556	2.96	.0004907	.42790	2.23	.0003697	.32236
56209	.01664	950	15.8086	2.59	.0004310	.40945	2.21	.0003677	.34937
57005	.01746	88	1.5364	2.71	.0004731	.04164	2.09	.0003649	.03211
57305	.01666	501	8.5777	3.19	.0005826	.29188			
57308	.01705	577	9.8378	1.69	.0002881	.16626			
57509	.01739	611	10.6261	2.54	.0004417	.26990			
59606	.01712	567	9.7084	2.16	.0003698	.20970			
60605	.01701	35	.5952	1.87	.0003180	.01113			
63105	.01717	90	1.5452	3.24	.0005563	.05007			
66006	.01642	366	6.0090	3.54	.0005812	.21272	1.38	.0002266	.08292

TABLE 10.—*Analyses of plants, arranged according to weight of average kernel. Crop of 1903*—Continued.

WEIGHT OF AVERAGE KERNEL, 0.016 TO 0.018 GRAM—Continued.

Record number.	Weight of average kernel (gram).	Number of kernels on plant.	Weight of kernels on plant (grams).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in—		Percentage of gliadin-plus-glutenin nitrogen in kernels.	Gliadin-plus-glutenin nitrogen (gram) in—	
					Average kernel.	Kernels on plant.		Average kernel.	Kernels on plant.
72605.....	0.01718	65	1.1166	4.65	0.0007988	0.05192	....	....	....
72606.....	.01724	543	9.3629	1.89	.0003414	.18538	....	....	....
74506.....	.01781	23	.4096	2.73	.0004862	.01118	....	....	....
74605.....	.01784	399	7.1181	2.60	.0004638	.18507	....	....	....
74607.....	.01699	491	8.3406	2.56	.0004349	.21352	....	....	....
76205.....	.01695	498	8.4407	2.35	.0003983	.19836	....	....	....
81406.....	.01721	72	1.2391	3.31	.0005697	.04101	....	....	....
85205.....	.01625	214	3.4766	2.60	.0004224	.09039	....	....	....
86106.....	.01749	436	7.6241	2.63	.0004599	.20052	....	....	....
91905.....	.01739	198	3.4436	3.36	.0005844	.11570	....	....	....
91906.....	.01774	200	3.5486	2.81	.0004986	.09972	....	....	....
92207.....	.01767	209	3.6926	2.55	.0004505	.09416	....	....	....
92306.....	.01732	347	6.0091	4.93	.0008539	.29625	4.06	0.0007032	0.24397
92405.....	.01605	214	3.4356	3.10	.0004977	.10650	....	....	....
92407.....	.01695	53	.8983	1.66	.0002814	.01491	....	....	....
92505.....	.01706	156	2.6615	3.00	.0005118	.07985	....	....	....
92506.....	.01690	229	3.8709	4.39	.0007421	.16993	....	....	....
92908.....	.01732	187	3.2388	2.32	.0004018	.07514	....	....	....
94407.....	.01615	419	6.7664	2.07	.0003343	.14007	....	....	....
94909.....	.01696	218	3.6977	3.60	.0006106	.13312	....	....	....
95510.....	.01783	159	2.8356	1.81	.0003228	.05132	....	....	....
95705.....	.01626	636	10.3426	2.54	.0004131	.26270	....	....	....
Average.	.01709	305.9	5.2055	2.93	.0005020	.14618	2.07	.0003519	.13548

WEIGHT OF AVERAGE KERNEL, 0.018 TO 0.020 GRAM.

Record number.	Weight of average kernel (gram).	Number of kernels on plant.	Weight of kernels on plant (grams).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in average kernel.	Proteid nitrogen (gram) in kernels on plant.	Percentage of gliadin-plus-glutenin nitrogen in kernels.	Gliadin-plus-glutenin nitrogen (gram) in average kernel.	Gliadin-plus-glutenin nitrogen (gram) in kernels on plant.
17305.....	0.01984	183	3.6302	3.03	0.0006010	0.10999	....	....	....
17408.....	.01852	497	9.2038	2.18	.0004037	.20065	....	....	....
17409.....	.01857	802	14.8957	2.75	.0005108	.40964	....	....	....
20710.....	.01974	867	17.1115	2.83	.0005586	.48428	2.00	0.0003948	0.34222
21205.....	.01922	123	2.3642	3.16	.0006074	.07471	....	....	....
21206.....	.01917	149	2.8564	5.23	.0010026	.14939	....	....	....
21207.....	.01955	118	2.3066	2.96	.0005766	.06804	....	....	....
21306.....	.01837	226	4.1516	2.90	.0005327	.12039	....	....	....
21711.....	.01968	873	17.1820	2.71	.0005334	.46563	....	....	....
21809.....	.01919	418	8.0214	2.73	.0005238	.21898	2.18	.0004183	.17487
21810.....	.01982	52	1.0304	2.69	.0005330	.02772	....	....	....
21813.....	.01877	216	4.0258	4.04	.0007582	.16377	2.14	.0004017	.08615
21905.....	.01809	791	14.3111	2.64	.0004777	.37781	2.18	.0003944	.31198
21907.....	.01851	158	2.9248	3.35	.0006201	.09798	2.15	.0003980	.06288
21912.....	.01907	510	9.7236	2.31	.0004404	.22461	....	....	....
22207.....	.01940	169	3.2787	2.77	.0005374	.09082	1.82	.0003531	.05967
26905.....	.01966	326	6.4102	2.76	.0005427	.17692	2.09	.0004109	.13398
26906.....	.01859	228	4.2376	2.71	.0005037	.11484	1.82	.0003383	.07712
27005.....	.01895	866	16.4120	2.63	.0004984	.43164	1.90	.0003600	.31182
27205.....	.01841	891	16.4061	2.41	.0004437	.39539	1.70	.0003130	.27890
27306.....	.01945	684	13.3011	2.47	.0004803	.32853	....	....	....
27307.....	.01847	167	3.0850	2.53	.0004674	.07805	....	....	....
27507.....	.01833	75	1.3746	3.08	.0005646	.04234	....	....	....
28206.....	.01996	219	4.3698	3.07	.0006126	.13415	2.42	.0004830	.10575
32207.....	.01822	69	1.2573	3.48	.0006341	.04375	....	....	....
32608.....	.01851	55	1.0183	3.78	.0006998	.03849	....	....	....
33105.....	.01939	132	2.5601	2.91	.0005644	.07450	3.50	.0006787	.07450
33107.....	.01919	318	6.1026	2.35	.0004510	.14341	1.92	.0004163	.12643
33405.....	.01930	421	8.1268	2.03	.0003919	.16498	....	....	....
33906.....	.01921	119	2.2862	2.81	.0005399	.06424	....	....	....
34205.....	.01972	464	9.1498	2.73	.0005383	.24979	....	....	....
34206.....	.01968	81	1.5940	3.73	.0007340	.05946	....	....	....
34208.....	.01916	156	2.9886	2.13	.0004081	.06366	....	....	....
34405.....	.01994	207	4.1281	4.33	.0008635	.17875	2.44	.0004865	.10073
36905.....	.01880	267	5.0200	3.88	.0007295	.19478	....	....	....
37305.....	.01987	309	6.1394	2.96	.0005881	.18173	2.29	.0004550	.14060
37705.....	.01972	461	8.0905	2.64	.0005327	.23998	1.26	.0002485	.10194
38005.....	.01808	139	2.5134	2.84	.0005135	.07138	1.23	.0002224	.03091
38506.....	.01975	85	1.6799	2.89	.0005712	.04855	....	....	....
38605.....	.01987	61	1.2124	5.85	.0011627	.07093	....	....	....
38608.....	.01913	158	3.0228	2.82	.0005394	.08522	1.73	.0003309	.05229
38706.....	.01988	365	7.2545	2.59	.0005148	.18789	....	....	....
40205.....	.01871	194	3.6302	4.69	.0008776	.17026	3.07	.0005744	.11145

TABLE 10.—*Analyses of plants, arranged according to weight of average kernel. Crop of 1903*—Continued.

WEIGHT OF AVERAGE KERNEL, 0.018 TO 0.020 GRAM—Continued.

Record number.	Weight of average kernel (gram).	Number of kernels on plant.	Weight of kernels on plant (grams).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in—		Percentage of gliadin-plus-glutenin nitrogen in kernels.	Gliadin-plus-glutenin nitrogen (gram) in—	
					Average kernel.	Kernels on plant.		Average kernel.	Kernels on plant.
42205	0.01967	94	1.8494	3.63	0.0007142	0.06713	2.73	0.0005370	0.05049
42905	.01866	67	1.2499	3.17	.0005447	.03650			
44607	.01806	101	1.8246	2.44	.0004408	.04452			
45606	.01834	220	4.0358	1.91	.0003504	.07708			
46106	.01964	82	1.6103	2.54	.0004988	.04090			
48106	.01919	608	11.6655	2.38	.0004567	.27765	1.80	.0003454	.20997
48508	.01858	603	11.2008	2.76	.0005127	.30986			
49505	.01898	67	1.2716	3.24	.0006149	.04120			
50705	.01986	30	.5958	3.54	.0007032	.02109			
51005	.01804	862	15.5835	1.34	.0002422	.20881			
55007	.01828	118	2.1571	4.21	.0007696	.09082	2.21	.0004040	.04767
55008	.01846	944	17.4226	2.60	.0004799	.45299	1.58	.0002917	.27528
55206	.01965	578	11.3592	2.56	.0005031	.29079	1.87	.0003675	.21241
55306	.01931	214	4.1323	2.18	.0004210	.09008			
55507	.01949	504	9.8228	2.63	.0005126	.25834	2.07	.0004034	.20333
56106	.01866	644	12.0161	2.57	.0004795	.30881	2.09	.0003900	.25114
56205	.01959	333	6.5232	2.51	.0004917	.16373	1.85	.0003624	.12068
56206	.01829	509	9.3093	2.42	.0004426	.22529	1.95	.0003566	.18153
57007	.01975	168	3.3176	2.65	.0005233	.08792			
57306	.01838	434	7.9772	2.86	.0005257	.22815			
57307	.01801	261	4.7117	2.43	.0004387	.11445			
57406	.01846	135	2.4923	2.75	.0005077	.06854	2.13	.0003932	.05309
57407	.01968	762	14.9992	2.62	.0005157	.39297	1.86	.0003660	.27898
57507	.01946	359	6.9861	2.85	.0005545	.19905	1.55	.0003016	.10828
57608	.01968	438	8.6189	2.64	.0005195	.22756			
57805	.01814	270	4.8988	2.87	.0005207	.14060	2.68	.0004861	.13126
58805	.01999	1,158	23.1471	2.74	.0005464	.63422	2.11	.0004218	.48839
59605	.01880	382	7.1828	2.12	.0003986	.15228			
63505	.01934	208	4.0230	1.90	.0003674	.07644			
65306	.01807	544	9.8298	2.41	.0004282	.23690	1.68	.0003036	.16514
65307	.01878	373	7.0051	2.28	.0004355	.15971	1.81	.0003399	.12680
66008	.01814	174	3.1555	3.59	.0006510	.11328			
69305	.01984	103	2.0430	4.42	.0008767	.09030			
69505	.01847	255	4.7116	2.29	.0004231	.10790			
72406	.01929	430	8.2929	2.95	.0005689	.24464			
72607	.01832	188	3.4442	5.59	.0010241	.19253	2.51	.0004598	.08645
72806	.01906	110	2.0970	3.01	.0005738	.06312			
74507	.01869	493	9.2130	3.02	.0005644	.27823			
81405	.01862	240	4.5737	2.62	.0004879	.11710			
81505	.01940	146	2.8327	2.94	.0005704	.08328	2.65	.0005141	.07507
84905	.01927	37	.7130	2.32	.0004471	.01654			
84906	.01975	382	7.5438	3.43	.0006773	.25873			
88905	.01811	293	5.3069	2.83	.0005126	.15019			
88906	.01814	546	9.9034	2.65	.0004807	.26245			
92208	.01876	353	6.6206	2.72	.0005102	.18008			
92408	.01827	207	3.7820	2.97	.0005426	.11233			
92409	.01814	315	5.7131	2.30	.0004171	.13140			
92507	.01916	505	9.6779	2.58	.0004944	.24969			
92909	.01916	529	10.1363	2.70	.0005173	.27367			
94205	.01893	64	1.2117	1.65	.0003124	.01999			
94206	.01866	402	7.5006	2.78	.0005187	.20851			
94207	.01909	718	13.7057	2.86	.0005460	.39199			
94209	.01895	190	3.6006	2.49	.0004719	.08965			
94406	.01923	549	10.5556	2.47	.0004749	.26073			
94906	.01808	685	12.3862	3.41	.0006166	.42236			
94907	.01948	626	12.1918	2.94	.0005726	.35844			
94908	.01894	125	2.3678	1.96	.0003713	.04641			
95506	.01852	597	11.0548	2.74	.0005074	.30291			
95508	.01954	740	14.4617	2.56	.0005003	.37023			
95706	.01934	267	5.1629	2.73	.0005279	.14095			
Average	.01901	349.6	6.6327	2.88	.0005476	.18039	2.08	.0003979	.15541

WEIGHT OF AVERAGE KERNEL, 0.020 TO 0.022 GRAM.

17308	0.02012	61	1.2275	3.25	0.0006540	0.03994			
17405	.02127	738	15.6996	2.13	.0004531	.33441			
20706	.02033	163	3.3138	2.78	.0005652	.09212	2.05	0.0004168	0.06793
20708	.02024	122	2.4690	2.58	.0005221	.06399			
20709	.02063	258	5.3229	3.05	.0006292	.16235	2.31	.0004766	.12296
20805	.02157	697	14.6942	3.32	.0006999	.48784	2.26	.0004875	.33208

TABLE 10.—*Analyses of plants, arranged according to weight of average kernel. Crop of 1903*—Continued.

WEIGHT OF AVERAGE KERNEL, 0.020 TO 0.022 GRAM—Continued.

Record number.	Weight of average kernel (gram).	Number of kernels on plant.	Weight of kernels on plant (grams).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in—		Percentage of gliadin-plus-glutenin nitrogen in kernels.	Gliadin-plus-glutenin nitrogen (gram) in—	
					Average kernel.	Kernels on plant.		Average kernel.	Kernels on plant.
21212.....	0.02049	84	1.7216	2.16	0.0004427	0.03718	....	....	....
21305.....	.02004	312	6.2514	2.67	.0005350	.16691	1.97	0.0003948	0.12315
21707.....	.02125	582	12.3685	2.19	.0004654	.27086	....	....	....
21709.....	.02141	361	7.7296	2.47	.0005289	.19092	....	....	....
21811.....	.02101	567	11.9114	3.75	.0007877	.44666	2.16	.0004538	.25728
21908.....	.02056	173	3.5574	3.82	.0007855	.13589	1.88	.0003955	.06688
21913.....	.02072	492	10.1925	3.01	.0006235	.30680	....	....	....
22210.....	.02019	298	6.0173	3.17	.0006401	.19075	1.55	.0003129	.09327
22211.....	.02062	561	11.5675	3.17	.0006537	.36671	1.69	.0003485	.19548
25205.....	.02066	522	10.7836	2.71	.0005599	.28560	....	....	....
26908.....	.02073	192	3.9797	2.96	.0006135	.11780	2.16	.0004478	.08596
27207.....	.02004	166	3.3266	2.92	.0005850	.09712	1.95	.0003908	.06487
27305.....	.02085	267	5.5666	2.58	.0005379	.14362	1.73	.0003607	.09630
27505.....	.02183	539	12.0399	2.12	.0004627	.24942	1.65	.0003602	.19866
28806.....	.02111	685	14.4630	3.02	.0006376	.43679	1.86	.0003926	.26901
32206.....	.02052	507	10.4036	1.81	.0003714	.18831	....	....	....
32606.....	.02145	94	2.0162	2.88	.0006177	.05807	....	....	....
33305.....	.02090	150	3.1346	3.41	.0007126	.10689	2.41	.0005037	.07554
33606.....	.02144	382	8.1890	2.21	.0004738	.18098	....	....	....
33607.....	.02125	136	2.8903	3.22	.0006843	.09307	2.45	.0005206	.07081
33905.....	.02194	508	11.1476	1.61	.0003533	.17948	....	....	....
37705.....	.02155	56	1.2069	2.34	.0005053	.02824	....	....	....
38606.....	.02110	401	8.4605	2.63	.0005549	.22251	1.39	.0002933	.11760
39205.....	.02089	1,031	21.5399	2.11	.0004407	.45435	1.84	.0003844	.39635
39405.....	.02093	447	9.3541	2.88	.0006027	.21399	1.44	.0003014	.13470
40305.....	.02011	179	3.6003	3.11	.0006255	.11197	....	....	....
44605.....	.02049	55	1.1271	2.86	.0005861	.03223	....	....	....
44606.....	.02035	124	2.5235	2.90	.0005902	.07318	1.29	.0002625	.03255
48409.....	.02048	314	6.4302	2.02	.0004137	.12989	1.50	.0003072	.09645
55005.....	.02028	393	7.9684	3.05	.0006185	.24303	1.99	.0004036	.15857
55506.....	.02062	866	17.8506	2.80	.0005773	.4995	2.20	.0004536	.39272
55605.....	.02184	500	10.9180	2.64	.0005765	.28823	1.96	.0004281	.21400
55908.....	.02175	562	12.2210	2.42	.0005262	.29575	1.96	.0004263	.23953
57405.....	.02031	41	.8328	1.98	.0004022	.01649	....	....	....
57408.....	.02047	596	12.2004	2.61	.0005343	.31842	1.64	.0003357	.20008
58806.....	.02049	95	1.9469	1.88	.0003853	.03660	....	....	....
63106.....	.02001	165	3.3006	2.79	.0005581	.09208	2.20	.0004402	.07261
65308.....	.02008	583	11.7066	2.09	.0004197	.24468	1.95	.0003916	.22828
66005.....	.02073	370	7.6690	2.63	.0005451	.20170	2.18	.0004519	.16714
69506.....	.02047	663	13.5696	2.50	.0005117	.33923	....	....	....
69806.....	.02153	558	12.0136	1.66	.0003574	.19943	....	....	....
72705.....	.02191	372	9.1522	2.13	.0004668	.19936	....	....	....
72707.....	.02036	225	4.5806	3.49	.0007105	.15986	....	....	....
73306.....	.02062	414	8.5373	2.45	.0005052	.20918	....	....	....
74305.....	.02047	216	4.4222	1.98	.0004054	.08756	....	....	....
74606.....	.02079	464	9.6451	2.30	.0004781	.22184	2.05	.0004262	.19772
80305.....	.02165	729	15.7835	1.81	.0003919	.28569	1.77	.0003832	.27937
81705.....	.02106	465	9.7922	1.98	.0004170	.19388	1.96	.0004128	.19193
81706.....	.02132	722	15.3928	2.71	.0005778	.41715	2.03	.0004328	.31248
81709.....	.02175	757	16.4692	2.28	.0004960	.37548	....	....	....
84405.....	.02043	428	8.7448	2.48	.0005067	.21687	....	....	....
88606.....	.02068	481	9.9456	2.53	.0005231	.25162	....	....	....
88608.....	.02075	74	1.5355	2.47	.0005125	.03793	....	....	....
88609.....	.02100	470	9.8719	2.42	.0005082	.23890	....	....	....
92406.....	.02168	380	8.2366	3.11	.0006741	.25616	....	....	....
92907.....	.02040	219	4.4673	2.56	.0005220	.11436	....	....	....
95507.....	.02029	571	12.1592	2.59	.0005515	.31492	....	....	....
95509.....	.02136	138	2.9475	2.48	.0005297	.07310	....	....	....
Average.	.02085	386.6	8.1267	2.60	.0005422	.20510	1.92	.0003999	.17351

WEIGHT OF AVERAGE KERNEL, 0.022 TO 0.024 GRAM.

17307.....	0.02279	138	3.1454	3.46	0.0007886	0.10883	....	....	....
17410.....	.02285	744	16.9987	2.88	.0006580	.48957	....	....	....
20707.....	.02282	444	9.9070	2.77	.0006181	.27443	1.85	0.0004222	0.18328
21706.....	.02390	807	19.3318	4.71	.0011283	.91052	....	....	....
21708.....	.02381	390	9.2850	2.33	.0005547	.21634	....	....	....
21806.....	.02378	599	14.2450	2.71	.0006444	.38604	....	....	....
21909.....	.02317	525	12.1819	4.43	.0010265	.53889	1.98	.0005677	.29846
21911.....	.02209	383	8.4593	5.48	.0012103	.46356	....	....	....

TABLE 10.—*Analyses of plants, arranged according to weight of average kernel. Crop of 1903*—Continued.

WEIGHT OF AVERAGE KERNEL, 0.022 TO 0.024 GRAM—Continued.

Record number.	Weight of average kernel (gram).	Number of kernels on plant.	Weight of kernels on plant (grams).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in— Average kernel.	Proteid nitrogen (gram) in— Kernels on plant.	Percentage of gliadin-plus-glutenin nitrogen in kernels.	Gliadin-plus-glutenin nitrogen (gram) in— Average kernel.	Gliadin-plus-glutenin nitrogen (gram) in— Kernels on plant.
25206.....	0.02281	205	4.6754	2.76	0.0006295	0.12904	....	....	....
26106.....	.02304	90	2.0737	2.63	.0006060	.05454	....	....	....
26805.....	.02248	220	4.9456	2.81	.0006317	.13897	....	....	....
26807.....	.02390	721	17.2324	2.80	.0006692	.48250	....	....	....
27506.....	.02252	444	10.0005	2.70	.0006082	.27003	1.98	0.0004459	0.19800
27508.....	.02287	251	5.5324	2.64	.0006037	.14608	2.32	.0005306	.12835
27509.....	.02206	243	5.3615	2.90	.0006399	.15549	1.69	.0002405	.05844
32605.....	.02323	225	5.2268	1.20	.0002788	.06272	....	....	....
33407.....	.02271	305	7.0889	1.62	.0003679	.11223	....	....	....
33605.....	.02345	301	7.0596	2.39	.0005605	.16872	1.92	.0004502	.13554
34207.....	.02219	611	13.5556	2.84	.0006273	.38505	....	....	....
34606.....	.02213	280	6.1962	3.12	.0006904	.19332	....	....	....
38505.....	.02252	563	12.1088	3.61	.0007764	.43713	1.77	.0003986	.21432
38609.....	.02309	293	6.7665	2.74	.0006475	.18540	1.34	.0003094	.09067
42405.....	.02251	66	1.4892	3.07	.0006927	.04572	....	....	....
43405.....	.02258	124	2.8000	2.92	.0006594	.08176	1.18	.0002664	.03304
48507.....	.02296	70	1.6036	2.64	.0006062	.04233	....	....	....
55308.....	.02395	397	9.5078	2.54	.0006225	.24150	....	....	....
55606.....	.02205	503	11.0930	2.58	.0005690	.28580	1.49	.0002609	.16529
56207.....	.02361	462	10.9073	2.34	.0005524	.25522	1.83	.0004321	.19960
56208.....	.02356	563	13.5720	2.61	.0006149	.34616	1.95	.0004594	.26465
57606.....	.02333	132	3.0790	2.74	.0006391	.08436	....	....	....
57607.....	.02234	736	16.4433	1.73	.0003865	.24847	....	....	....
63107.....	.02233	417	9.3120	2.43	.0005426	.22628	....	....	....
65305.....	.02310	78	1.8018	4.92	.0011365	.08865	....	....	....
69805.....	.02220	110	2.4420	5.82	.0012921	.14213	1.94	.0004307	.04738
71905.....	.02239	1,260	28.2136	2.47	.0005531	.69688	....	....	....
72708.....	.02270	398	9.0386	2.27	.0005154	.20518	....	....	....
73307.....	.02229	25	.5572	2.39	.0005327	.01332	....	....	....
73308.....	.02291	624	14.2986	2.92	.0006539	.41752	....	....	....
81707.....	.02336	786	18.3614	2.34	.0005466	.42965	....	....	....
81710.....	.02308	396	9.1411	1.92	.0004432	.17550	....	....	....
88607.....	.02205	234	5.1584	2.61	.0005754	.13463	....	....	....
91305.....	.02242	138	3.0940	3.21	.0007197	.09932	....	....	....
Average.	.02285	388.1	8.8879	2.90	.0006624	.25166	1.74	.0004011	.15515

WEIGHT OF AVERAGE KERNEL, 0.024 TO 0.026 GRAM.

Record number.	Weight of average kernel (gram).	Number of kernels on plant.	Weight of kernels on plant (grams).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in— Average kernel.	Proteid nitrogen (gram) in— Kernels on plant.	Percentage of gliadin-plus-glutenin nitrogen in kernels.	Gliadin-plus-glutenin nitrogen (gram) in— Average kernel.	Gliadin-plus-glutenin nitrogen (gram) in— Kernels on plant.
17506.....	0.02460	93	2.2881	3.52	0.0008660	0.08044	2.23	0.0005486	0.05102
21807.....	.02498	377	9.4172	2.73	.0006664	.25709	2.11	.0005271	.19870
21906.....	.02563	408	10.4800	3.18	.0008168	.33403	2.10	.0005382	.22008
27206.....	.02469	777	19.1854	2.36	.0005827	.45276	1.46	.0003605	.28010
28805.....	.02512	87	2.1851	2.91	.0007309	.06359	1.55	.0003894	.03387
37905.....	.02555	37	.9452	2.53	.0006463	.02391	....	....	....
40505.....	.02444	170	4.1546	2.82	.0006892	.11716	2.19	.0005352	.09099
48305.....	.02543	473	12.0278	2.87	.0007299	.34524	1.77	.0004501	.21289
55907.....	.02590	749	19.3966	2.59	.0006707	.50238	1.61	.0004170	.31229
72706.....	.02484	591	14.6802	3.86	.0009588	.56666	....	....	....
81708.....	.02578	287	7.3993	2.41	.0006213	.17833	1.64	.0004228	.12135
92206.....	.02407	46	1.1074	2.67	.0006428	.02957	....	....	....
94105.....	.02543	22	.5595	2.67	.0006790	.01494	....	....	....
Average.	.02511	316.7	7.9866	2.86	.0007154	.22816	1.85	.0004654	.16903

WEIGHT OF AVERAGE KERNEL, 0.026 GRAM AND OVER.

Record number.	Weight of average kernel (gram).	Number of kernels on plant.	Weight of kernels on plant (grams).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in— Average kernel.	Proteid nitrogen (gram) in— Kernels on plant.	Percentage of gliadin-plus-glutenin nitrogen in kernels.	Gliadin-plus-glutenin nitrogen (gram) in— Average kernel.	Gliadin-plus-glutenin nitrogen (gram) in— Kernels on plant.
21211.....	0.02806	10	0.2806	3.15	0.0008839	0.00884	....	....	....
21705.....	.02659	58	1.5420	2.45	.0006514	.03778	....	....	....
39506.....	.02869	67	1.9218	2.93	.0008404	.05631	2.06	0.0005915	0.03959
49905.....	.02939	23	.6760	3.62	.0010640	.02436	....	....	....
55608.....	.02699	837	22.5848	2.31	.0006236	.52194	....	....	....
55909.....	.03050	302	9.2120	2.30	.0007016	.21187	1.66	.0005063	.15292
57508.....	.03177	380	12.0728	2.21	.0007021	.26680	2.05	.0006513	.24750
58505.....	.02730	273	7.4516	2.95	.0008052	.21982	....	....	....
72405.....	.03963	213	8.4415	3.36	.0013316	.28363	....	....	....
Average.	.02988	240.3	7.2425	2.81	.0008449	.18126	1.92	.0005829	.14667

TABLE 11.—*Summary of analyses of plants, arranged according to weight of average kernel. Crop of 1903.*

Range of weights of average kernel (gram).	Number of analyses.	Weight of average kernel (gram).	Number of kernels.	Weight of kernels (grams).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in—		Per centage of gliadin-plus-glutenin nitrogen in kernels.	Gliadin-plus-glutenin nitrogen (gram) in—	
						Average kernel.	Kernels.		Average kernel.	Kernels.
0.000 to 0.010....	4	0.00915	219	2.0334	2.76	0.0002528	0.05618	1.97	0.0001877	0.05312
0.010 to 0.012....	6	.01118	179	2.0187	2.98	.0003326	.06276	2.69	.0002968	.06752
0.012 to 0.014....	19	.01323	155.7	2.0510	3.12	.0004120	.06687	1.98	.0002641	.07499
0.014 to 0.016....	27	.01516	232	3.5480	3.00	.0004555	.10619	1.76	.0002805	.09320
0.016 to 0.018....	69	.01709	305.9	5.2055	2.93	.0005020	.14618	2.07	.0003519	.13548
0.018 to 0.020....	103	.01901	349.6	6.6327	2.88	.0005476	.18039	2.08	.0003979	.15541
0.020 to 0.022....	64	.02085	386.6	8.1257	2.60	.0005422	.20510	1.92	.0003999	.17351
0.022 to 0.024....	42	.02285	388.1	8.8879	2.90	.0006624	.25166	1.74	.0004011	.15515
0.024 to 0.026 ...	13	.02511	316.7	7.9866	2.86	.0007154	.22816	1.85	.0004654	.16903
0.026 and over..	9	.02988	240.3	7.2425	2.81	.0008449	.18126	1.92	.0005829	.14667

With an increase in the weight of the kernel, as shown by this table, there is an irregular increase in the number of kernels on the plant up to a point somewhat beyond the kernel of average weight, after which there is a decrease. The weight of the kernels on the plant seems to follow the same rule. The percentage of proteid nitrogen in the kernels decreases, in general, with the weight of the average kernel, while the number of grams of proteid nitrogen in the average kernel increases steadily. The grams of proteid nitrogen in all the kernels on the plant increase up to the same point as do the number of kernels on the plant, and then decrease.

Table 12 shows the summary of the analyses of the crop of 1903, arranged according to the grams of proteid nitrogen in the average kernel. All plants having less than 0.0003 gram of proteid nitrogen form the first class, and the following classes increase with each 0.0001 gram of proteid nitrogen.

It is difficult to trace any relation between the grams of proteid nitrogen in the average kernel and the number of kernels on the plant, or the weight of the kernels on the plant. The weight of the average kernel increases directly with the grams of proteid nitrogen in the kernel. The percentage of proteid nitrogen increases regularly with an increase in the grams of proteid nitrogen in the average kernel. The grams of proteid nitrogen in all the kernels on the plant show no definite relation to the grams of proteid nitrogen in the average kernel.

It becomes evident from these results that selection of large, heavy kernels for seed would result in discarding the immature and unsound kernels, but that there would also be discarded many sound kernels, which, although small and of low specific gravity, would contain a high percentage of proteids.

Another effect of such selection, as indicated by the foregoing results, would be to increase the yield of grain from each plant when grown under the conditions that obtained in these experiments. What the effect would be upon the yield under ordinary field conditions these experiments do not indicate.

On the other hand, selection based upon percentage of proteid nitrogen alone would not result in securing plants of greatest yield when raised under these conditions. It would, moreover, not result in obtaining plants producing the greatest amount of proteid nitrogen, nor even of kernels containing the largest quantity of proteid nitrogen.

TABLE 12.—*Summary of analyses of plants, arranged according to grams of proteid nitrogen in average kernel. Crop of 1903.*

Range of proteid nitrogen in average kernel (gram).	Proteid nitrogen in average kernel (gram).	Number of analyses.	Number of kernels on plant.	Weight (in grams) of—		Percentage of proteid nitrogen in kernels.	Proteid nitrogen in kernels on plant (gram).
				Kernels on plant.	Average kernel.		
Below 0.00030	0.0002509	14	257.9	3.9190	0.01364	1.96	0.06531
0.00030 to 0.00040	.0003602	42	266.7	4.6742	.01628	2.31	.09644
0.00040 to 0.00050	.0004537	80	409.2	7.5309	.01811	2.54	.18644
0.00050 to 0.00060	.0005406	116	341.5	6.7159	.01908	2.86	.18440
0.00060 to 0.00070	.0006409	59	310.3	6.7257	.02137	3.07	.19805
0.00070 to 0.00080	.0007430	24	204.9	4.5158	.02110	3.66	.15318
0.00080 to 0.00090	.0008538	9	189.1	4.2480	.02334	3.79	.15944
0.00090 to 0.00100	.0009588	1	591.0	14.6802	.02484	3.86	.56666
0.00100 and over	.0011578	11	244.9	6.6082	.02875	4.62	.27980

It will be shown later that the determination of gliadin-plus-glutenin nitrogen is a safer guide to the bread-making value of wheat than is a determination of proteid nitrogen, but whether selection should be based upon the percentage of nitrogen or the total production of nitrogen by the plant, or upon the amount contained in the average kernel, is a question that can not be solved except by trial under field conditions.

Some results of experiments with light and with heavy seed conducted on large field plots for several years may throw some light on this subject, and are given herewith.

YIELD OF NITROGEN PER ACRE.

It is important to know whether the absolute amount of nitrogen per acre of grain raised is greater in light or in heavy wheat.

If the absolute amount of nitrogen per acre is less in light than in heavy wheat the supposition would be justifiable that the kernels were immature or had been prematurely checked in their development. On the other hand, if the amount of nitrogen per acre is greater in the light wheat it would be reasonable to suppose that, as both had been raised under the same conditions, the light wheat had, in part at least, come from plants that possessed greater ability to acquire and elaborate nitrogenous material.

To afford information on this point analyses were made of crops grown from light and from heavy seed. Records of the yields of the plots were kept in each case so that the actual amount of proteid nitrogen contained in an acre of each kind of wheat can be calculated. The number of grams of proteid nitrogen in 1,000 kernels of each seed and crop sample is also stated. The first samples separated, Nos. 78 and 79 of the Turkish Red variety and 80 and 81 of the Big Frame variety, were taken from seed that had never before been treated in this way. When planted they produced the crops indicated in Table 13 by 78b, 79b, 80b, and 81b, respectively. Each of these crops was then separated into two portions, of which the light portion of the light wheat was retained for analyzing and planting, and the heavy portion of the heavy wheat likewise retained. Thus No. 383 is the light portion of No. 78b, and No. 384 is the heavy portion of No. 79b.

The accuracy of the records of relative yields of light and heavy seed harvested in 1902 being open to suspicion, samples of the same seed were sown again in the autumn of 1902 and harvested in 1903. The results from this test are stated at the bottom of the table under the heading "Check experiment."

These experiments are to be understood as duplicating those of 1902, which, as regards the relative yield of light and heavy wheat, should be accurate, although tried in 1903. The difference between this check experiment and the regular one of 1903 is that in the check experiment the seed of the crop of 1901 was used, while in the regular experiment in 1903 the seed of the crop of 1902 was used.

TABLE 13.—*Crops grown from light and from heavy seed for four years.*

SEED.

Farm number.	Variety.	Percentage of—			Weight of 1,000 kernels. (grams).	Proteid nitrogen in 1,000 kernels (gram).	Relative weight.
		Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.			
78	Turkish Red				17.24		Light.
79	....do				30.63		Heavy.
80	Big Frame	2.45	2.00	0.45	15.57	0.3120	Light.
81	....do	2.20	1.96	.24	28.56	.5606	Heavy.
383	Turkish Red	3.12	3.10	.02	27.11	.8401	Light.
384	....do	3.02	2.93	.09	28.47	.8350	Heavy.
385	Big Frame	3.13	2.82	.31	27.11	.7642	Light.
386	....do	2.95	2.65	.30	28.09	.7446	Heavy.
	Turkish Red						Light.
	....do						Heavy.
	Big Frame						Light.
	....do						Heavy.
957	Turkish Red	3.33	2.87	.46			Light.
956	....do	3.06	2.86	.20			Heavy.
952	Big Frame	2.88	2.63	.25			Light.
953	....do						Heavy.
	CHECK EXPERIMENT.						
	Turkish Red						Light.
	....do						Heavy.
	Big Frame						Light.
	....do						Heavy.

TABLE 13.—*Crops grown from light and from heavy seed for four years*—Continued.

CROP.

Farm number of seed.	Variety.	Yield per acre (bushels).	Weight per bushel (pounds).	Percentage of— Total nitrogen.	Proteid nitrogen.	Nonproteid nitrogen.	Proteid nitrogen per acre (pounds).	Weight of 1,000 kernels (grams).	Proteid nitrogen in 1,000 kernels (gram).	Year grown.	Farm number of crop.
78	Turkish Red	23.0	......	3.20	3.09	0.11	45.54	......	....	1900	78b
79	....do	29.5	......	3.08	2.94	.14	52.04	25.10	0.7379	1900	79b
80	Big Frame	20.5	......	3.13	3.06	.07	37.63	......	....	1900	80b
81	....do	25.1	......	2.81	2.59	.22	39.01	24.84	.6423	1900	81b
383	Turkish Red	26.7	60.5	2.35	2.13	.22	34.12	26.19	.5581	1901	612
384	....do	29.3	61.5	2.11	1.94	.17	34.11	27.04	.5238	1901	613
385	Big Frame	21.2	58.0	3.30	3.06	.24	38.92	23.89	.7409	1901	602
386	....do	27.7	60.5	2.46	2.24	.22	37.22	28.82	.6451	1901	603
	Turkish Red	19.7	57.0	2.15	2.14	.01	25.29	......	....	1902	621
	....do	18.0	58.0	1.98	1.87	.11	20.20	......	....	1902	614
	Big Frame	Lost.	......	3.54	3.32	.22	......	19.56	.6494	1902	604
	....do	Lost.	......	2.44	2.21	.23	......	26.41	.5837	1902	611
957	Turkish Red	25.6	......	....	3.51	....	53.91	22.12	.7764	1903	1240
956	....do	21.3	......	....	2.18	....	27.86	23.13	.5042	1903	1239
952	Big Frame	25.8	......	....	2.14	....	33.13	19.82	.4241	1903	1248
953	....do	20.8	......	....	1.98	....	24.71	23.26	.4605	1903	1249
	CHECK EXPERIMENT.										
	Turkish Red	30.9	......	....	1.95	....	36.34	......	....	1903	1245
	....do	31.8	......	....	1.64	....	31.29	......	....	1903	1243
	Big Frame	23.9	......	....	1.79	....	25.67	......	....	1903	1252
	....do	24.2	......	....	1.62	....	23.52	......	....	1903	1254

Comparing the analyses of the light and heavy seed in this table with those in the preceding tables, it will be noticed that the total and proteid nitrogen are both uniformly higher in the light seed. The nonproteid nitrogen is not so uniform as in the previous analyses, but the general tendency is the same.

In the crop the high total and proteid nitrogen of the light seed is uniformly transmitted. There is no uniformity in the nonproteid nitrogen. As was to be expected, the heavy seed produced in the first two years the largest yields per acre. The quality of light or heavy weight as indicated in the resulting crop by weight of grain per bushel gave some indication of being transmitted. In 1900 there was an absence of data on the subject, but in 1901 the heavy seed in each case produced grain having a greater weight per bushel than did the light seed.

Turning to the column showing the absolute amount of proteid nitrogen produced per acre, it is very apparent that the heavy seed produced in 1900 considerably larger amounts of proteid nitrogen per acre than did the light seed, but in 1901 the difference was very slightly in favor of the light wheat, which advantage continued with the light wheat during the remaining years.

It would seem from these results that the quality of lightness, with its correlated qualities of high total and proteid nitrogen, is hereditary. The question then arises, Why should the light wheat accumulate more nitrogen per acre than the heavy wheat after the first generation?

A possible explanation for this is that the light seed from the first generation contained kernels whose lightness was due in some cases to immaturity, and in other cases to the individual peculiarity of the plant on which they grew. The latter class transmitted this peculiarity in the crop, while the former became less conspicuous with each generation, on account of the lesser vitality and productiveness of the immature seed.

A peculiar feature of these results is found in the fact that the yield of grain from the light seed approaches each succeeding year more nearly in quantity to that obtained from the heavy seed until, in 1903, it becomes greater. These two qualities of seed were raised on plots side by side, and every precaution was taken to obtain an accurate estimate of the yield of each. While it is probable that the results for 1903 are misleading, it is certainly significant that so little difference in yield exists after three years' selection in this way. Instead of the difference between the light and heavy seed becoming greater each year it is without doubt becoming less.

In considering the relative yields of the light and heavy wheat, it must be borne in mind that the seeding was done with a drill set to deliver 1½ bushels per acre of ordinary seed wheat. The result would be to deposit a larger number of kernels of light seed per acre than of heavy seed. In a season like that of 1903, when the rainfall was large and the weather moderately cool until harvest, there might be an advantage resulting from the thicker seeding, which may account for the greater yield from the light seed in that year.

It is possible that the same cause may have operated in other years to increase the yields from the light seed, but it is not likely that it produced a very marked effect, because the seeding was a large one for Nebraska, and, the wheat being sown in the early fall, there was abundant opportunity for it to stool, and thus equalize the stand. It has never been observed that there was any difference between the plots in this respect.

Taking, together, the results of 1902, which show a decrease in the weight of the kernels on a single head as the content of proteid nitrogen increases, the results of 1903, which show a slight decrease in the weight of the kernels from the plant, accompanying an increase in the percentage of proteid nitrogen, and the yields of the light and heavy seed for the four years beginning with 1900, there would appear to be a slight decrease in yield of grain, accompanying an increase in the percentage of proteid nitrogen. This loss in yield is

not sufficient to counteract the increase in nitrogen, and the result is to increase the production of proteids per acre.

Viewed in the light of these various experiments, the selection of large, heavy wheat kernels for seed does not appear to be altogether unobjectionable, as in this case it resulted in a decreased production of proteids per acre, without a compensating increase in the yield of grain, when continued for a number of years. On the other hand, the selection of the small, light seed is hardly to be recommended. In fact, selection based upon kernel size or weight is not a satisfactory method for permanently improving wheat. The individual plant should be taken as the basis for selection, and very large numbers should be handled. The figures in Table 8 show what great opportunity there is for securing not only kernels of high nitrogen content, but also plants giving at the same time an increased yield of grain and abundant production of proteids. If the average nitrogen content and yield of grain by plants be observed in this table, it will be seen that numerous plants may be selected that have not only a nitrogen content above the average, but also a greater yield of grain. While, therefore, it is probable that improvement in yield of grain can not be effected so rapidly where it is combined with improvement in nitrogen content as if the latter were neglected, yet present yields of wheat in Nebraska can be increased at the same time that the production of proteids is augmented.

METHOD FOR SELECTION TO INCREASE THE QUANTITY OF PROTEIDS IN THE KERNEL.

The following tables show the results of analyses of a total of forty-eight spikes of wheat. In the case of each spike one row of spikelets, for instance, row No. 1, was analyzed, and the other row of spikelets, which would then be row No. 2, was analyzed separately. In the case of the set of spikes forming Table 14 the total organic nitrogen was determined in both lots, and in the set comprised by Table 15 the proteid nitrogen was determined. The last column shows the difference between the nitrogen content of the two rows of kernels.

TABLE 14.—*Analyses of twenty-five spikes of wheat, showing their total organic nitrogen.*

Number of spike.	Percentage of total organic nitrogen.			Number of spike.	Percentage of total organic nitrogen.		
	Row 1.	Row 2.	Difference.		Row 1.	Row 2.	Difference.
1	3.14	3.32	0.18	18	2.83	2.79	0.04
2	2.97	3.15	.18	22	2.78	2.76	.02
3	2.89	2.99	.10	23	2.94	3.03	.09
7	2.99	3.21	.22	24	2.98	2.89	.09
8	2.89	2.82	.07	44	3.00	3.08	.08
9	2.82	2.81	.01	45	2.84	2.67	.17
10	2.50	2.76	.26	46	3.03	2.90	.13
11	3.13	3.11	.02	47	2.65	2.79	.14
12	3.11	3.18	.07	48	2.62	2.84	.22
13	2.76	2.80	.04	49	3.02	3.18	.16
14	2.85	2.79	.06	50	3.02	2.80	.22
15	3.26	3.07	.19				
16	2.94	3.07	.13	Average			.12
17	3.45	3.67	.22				

TABLE 15.—*Analyses of twenty-three spikes of wheat, showing their percentage of proteid nitrogen.*

Number of spike.	Percentage of proteid nitrogen.			Number of spike.	Percentage of proteid nitrogen.		
	Row 1.	Row 2.	Difference.		Row 1.	Row 2.	Difference.
4	2.90	3.12	0.22	34	2.86	3.02	0.16
5	2.97	2.86	.11	35	2.33	2.52	.19
20	2.68	2.79	.11	36	2.88	2.85	.03
21	2.54	2.76	.22	37	2.43	2.45	.02
25	2.42	2.53	.11	38	3.15	3.14	.01
26	2.42	2.50	.08	39	3.46	3.34	.12
27	3.01	2.91	.10	40	2.45	2.59	.14
28	2.35	2.71	.36	41	2.73	2.68	.05
29	2.72	2.75	.03	42	3.42	3.61	.19
30	2.49	2.44	.05	43	2.47	2.57	.07
31	2.92	3.09	.17				
32	2.60	2.48	.12	Average	2.77	2.82	.11
33	3.41	3.37	.04				

It will readily be seen that the analyses of the rows agree very closely, the extreme difference being 0.22 per cent, and the average difference being 0.12 per cent, in the total nitrogen. If, therefore, one row of spikelets were to be used for seed and the other were analyzed, it is quite evident that a very accurate estimate of the nitrogen content of the kernels used for seed would be obtained. In the determination of proteid nitrogen there is an extreme difference of 0.36 per cent in one case, but in the main the differences are small. As will be shown later, the variation in the proteid nitrogen content of individual plants is so great that even this maximum difference would cause no confusion when selecting plants for reproduction.

It is very desirable to have for analysis a larger sample than can be obtained from one spike. It has therefore been attempted to ascertain whether a sample consisting of one-half the whole number of spikes on a plant would afford a fair estimate of the composition of the other kernels on the remainder of the spikes. The plants whose spikes were analyzed were grown in hills 5 inches apart

each way, with one seed in each hill. Each plant was harvested separately and the spikes from each placed in a separate envelope. The following table gives the results, lot 1 in each case being composed of the kernels from one-half the number of spikes on a plant, and lot 2 of kernels from the remaining spikes.

TABLE 16.—*Analyses of twenty-one plants, showing total nitrogen and proteid nitrogen.*

Number of plant.	Percentage of total nitrogen.			Percentage of proteid nitrogen.		
	Lot 1.	Lot 2.	Difference.	Lot 1.	Lot 2.	Difference.
1	2.65	2.91	0.26	2.51	2.69	0.18
2	3.01	3.02	.01	2.77	2.76	.01
3	3.01	2.83	.24	2.69	2.57	.12
4	2.82	3.10	.28	2.63	2.83	.20
5	3.06	2.97	.09	2.92	2.70	.22
6	2.94	2.56	.38	2.51	2.42	.09
7	2.84	3.03	.19	2.66	2.86	.20
9	3.21	3.05	.16	2.83	2.84	.01
10	2.98	2.87	.11	2.59	2.70	.11
11	2.59	2.66	.07	2.34	2.57	.23
12	2.81	2.62	.19	2.59	2.52	.07
13	3.47	3.62	.15	3.04	3.35	.31
14	2.61	2.54	.07	2.44	2.42	.02
15	2.54	2.46	.08	2.25	2.29	.04
16	2.71	2.87	.16	2.25	2.71	.46
17	2.85	3.01	.16	2.73	2.75	.02
18	2.99	3.13	.14	2.85	2.91	.06
19	2.78	2.77	.01	2.61	2.33	.28
20	2.78	2.80	.02	2.60	2.57	.03
21	2.79	2.71	.08	2.51	2.48	.03
Average			.14			.13

The above table shows a maximum difference of 0.38 per cent in the content of total nitrogen of the two lots of spikes from one plant, and of 0.46 per cent in the content of proteid nitrogen. The average difference is only 0.14 per cent and 0.13 per cent, respectively.

These tables give unmistakable evidences that the average composition of a spike of wheat may be judged from the analysis of a row of its spikelets, and that the average composition of all of the spikes of a wheat plant is shown by an analysis of one-half the number. In practice it is better to take as the sample for analysis one row of spikelets from each spike, and the remaining row of spikelets from each spike for planting.

In order to ascertain what variation occurs between the several spikes on a single wheat plant, analyses were made of each spike from a number of plants. On some plants there were more spikes than on others, but every spike on each plant was analyzed. In the following tabulation of these analyses the percentage of proteid nitrogen is stated.

TABLE 17.—*Analyses of spikes of wheat, showing difference in proteid nitrogen.*

Spike.	Percentage oi proteid nitrogen.					
	Plant 23.	Plant 24.	Plant 25.	Plant 26.	Plant 27.	Plant 29.
1	2.33	2.46	2.31	2.73	3.22	2.38
2	2.69	2.73	2.36	3.02	3.24	2.60
3	2.37	2.35	2.47	2.80	3.02	3.03
4	2.36	2.11	2.59	2.60	3.31	3.00
5	2.15	2.19	2.35	2.53	....	2.34
6	2.31	2.21	2.39	2.37	....	2.71
7	2.09	2.53	2.39	2.72	....	2.21
8	2.71	....	2.60	2.37	....	....
9	2.32	....	2.54	2.61	....	2.60
10	2.37	....	2.83	2.45	....	2.30
Maximum	2.69	2.73	2.83	3.02	3.31	3.03
Average	2.37	2.37	2.48	2.62	3.20	2.57
Minimum	2.09	2.11	2.31	2.37	3.02	2.21
Greatest difference	.60	.62	.52	.65	.29	.82

These results show that there may be large differences between the proteid nitrogen content of spikes on the same plant. They do not, however, indicate that the determination of the average composition of the kernels on a plant is not a safe guide for selecting breeding stock. If the plant is the unit in reproduction, whether the plant reproduces itself from one seed or another does not affect its hereditary qualities in very marked degree.

It is evident, from a comparison of the variations that occur in the composition of the spikes from a single plant, and of the kernels on a single spike, that it is impossible to do more than obtain a reasonably close estimate of the composition of the kernels either on a part or on the whole of a plant. It therefore becomes desirable to obtain as closely as possible the average composition of the unit of reproduction. If the plant as a whole, and not any particular part, is this unit, the average composition of all of the kernels on the plant is a much safer guide as a basis for selection than is the average composition of the kernels of any part of it. One row of spikelets from each spike should therefore give the best sample for analysis.

In Table 18 is given a statement of the percentage of proteid nitrogen in the dry matter of the kernels on a row of spikelets of 800 spikes of wheat of the Turkish Red variety. These spikes were taken from a field of wheat, and were selected with reference to length of head, plumpness of kernel, uprightness of straw, freedom from rust, etc. They are therefore not spikes in which high nitrogen content is likely to be due to immaturity or arrested development.[a] Variations in the nitrogen content of different plants may in some degree be due to a larger or smaller supply of available nitrogen, although all were taken from the same field. Variations due to climate are, of course, precluded, as all grew during the same season.

[a] In practice undeveloped kernels are discarded.

TABLE 18.—*Variations in content of proteids.*

Record number.	Percentage of— Proteid nitrogen in water-free material.	Percentage of— Proteids (proteid N. × 5.7).	Record number.	Percentage of— Proteid nitrogen in water-free material.	Percentage of— Proteids (proteid N. × 5.7).	Record number.	Percentage of— Proteid nitrogen in water-free material.	Percentage of— Proteids (proteid N. × 5.7).
1	2.25	12.82	78	3.40	19.38	155	1.99	11.37
2	3.04	17.33	79	3.33	18.98	156	3.03	17.20
3	2.45	13.96	80	3.79	21.60	157	2.07	11.87
4	3.14	17.90	81	3.63	20.69	158	2.75	15.64
5	2.86	16.30	82	2.68	15.28	159	2.82	16.07
6	2.83	16.13	83	....	....	160	3.06	17.44
7	3.67	20.92	84	2.46	14.02	161	2.54	14.48
8	3.42	19.49	85	2.62	14.93	162	3.33	18.98
9	2.36	13.45	86	2.87	16.49	163	2.73	15.56
10	2.28	13.00	87	2.89	16.86	164	2.47	14.08
11	2.98	16.99	88	2.44	13.91	165	3.22	18.35
12	3.51	20.01	89	3.56	20.29	166	2.80	15.96
13	3.63	20.69	90	3.76	21.43	167	....	....
14	2.48	14.14	91	....	....	168	3.59	20.46
15	2.30	13.11	92	3.41	19.44	169	2.52	13.72
16	3.48	19.84	93	2.30	13.11	170	2.72	15.50
17	3.55	20.23	94	....	....	171	3.28	18.70
18	3.31	18.87	95	....	....	172	2.74	15.62
19	2.30	13.11	96	2.75	15.67	173	3.07	17.54
20	2.52	14.36	97	4.07	23.20	174	3.75	21.43
21	2.93	16.70	98	3.28	18.70	175	3.46	19.74
22	3.25	18.52	99	3.24	18.47	176	3.09	17.67
23	....	....	100	2.15	12.25	177	3.56	20.34
24	2.84	16.19	101	3.12	17.78	178	....	....
25	2.73	15.56	102	3.00	17.10	179	3.85	21.95
26	3.55	20.23	103	2.87	16.36	180	3.57	20.38
27	2.33	13.28	104	3.58	20.41	181	2.66	15.18
28	2.65	15.11	105	2.61	14.88	182	2.76	15.74
29	2.82	16.07	106	2.01	11.46	183	2.05	11.73
30	2.70	15.39	107	2.68	15.28	184	3.77	21.53
31	1.84	10.49	108	3.10	17.67	185	2.70	15.43
32	3.10	17.67	109	2.58	14.71	186	3.97	22.63
33	2.86	16.30	110	2.76	15.73	187	2.98	17.03
34	2.16	12.31	111	4.30	24.51	188	2.36	13.48
35	2.58	14.71	112	2.89	16.47	189	2.63	15.03
36	3.22	18.35	113	2.59	14.67	190	3.24	18.52
37	3.49	19.89	114	2.68	15.28	191	3.24	18.52
38	2.76	15.73	115	1.71	9.75	192	3.12	17.80
39	2.96	16.87	116	2.59	14.75	193	2.40	13.72
40	2.86	16.30	117	3.31	18.87	194	3.43	19.58
41	3.50	19.95	118	....	....	195	3.33	18.99
42	3.05	17.38	119	2.17	12.37	196	2.71	15.46
43	2.88	16.42	120	2.88	16.42	197	2.85	16.27
44	2.75	15.67	121	....	....	198	3.18	18.13
45	2.61	14.88	122	1.33	7.58	199	2.98	17.03
46	2.50	14.25	123	2.54	14.48	200	3.23	18.46
47	3.10	17.67	124	3.20	18.24	201	....	....
48	3.17	18.07	125	2.04	11.63	202	3.12	17.83
49	2.86	16.30	126	2.34	13.34	203	3.07	17.51
50	2.80	15.96	127	2.89	16.47	204	3.90	22.24
51	3.65	20.80	128	2.98	16.99	205	2.41	13.74
52	2.88	16.42	129	2.85	16.24	206	3.44	19.62
53	3.21	18.30	130	2.99	17.04	207	2.73	15.58
54	2.96	16.87	131	3.18	18.13	208	3.20	18.30
55	3.84	21.89	132	....	....	209	3.81	21.76
56	3.38	19.27	133	....	....	210	2.94	16.79
57	3.11	17.73	134	....	....	211	2.89	16.52
58	3.21	18.30	135	....	....	212	2.96	16.91
59	3.06	17.44	136	....	....	213	3.30	18.86
60	3.02	17.21	137	2.13	12.14	214	3.09	17.62
61	1.78	10.13	138	3.08	17.56	215	3.79	21.63
62	2.67	15.22	139	1.37	7.81	216	3.33	18.99
63	3.39	19.32	140	....	....	217	2.86	16.30
64	2.49	14.19	141	2.57	14.65	218	2.58	14.72
65	2.58	14.71	142	2.75	15.67	219	2.71	15.45
66	2.12	12.08	143	3.03	17.27	220	3.19	18.22
67	2.64	15.05	144	3.17	18.07	221	3.98	22.70
68	2.46	14.02	145	2.09	11.91	222	2.93	16.71
69	2.35	13.39	146	2.75	15.67	223	3.30	18.86
70	2.93	16.70	147	2.42	13.79	224	3.65	20.82
71	2.32	13.22	148	2.68	15.28	225	3.54	20.23
72	2.20	12.54	149	2.25	12.82	226	3.11	17.73
73	2.58	14.71	150	2.61	14.88	227	2.71	15.46
74	2.58	14.71	151	1.51	8.61	228	3.39	19.36
75	3.22	18.35	152	1.64	9.35	229	2.96	16.88
76	....	....	153	2.93	16.70	230	2.54	14.46
77	....	....	154	2.85	16.24	231	3.11	17.73

TABLE 18.—*Variations in content of proteids*—Continued.

Record number.	Percentage of— Proteid nitrogen in water-free material.	Percentage of— Proteids (proteid N. × 5.7).	Record number.	Percentage of— Proteid nitrogen in water-free material.	Percentage of— Proteids (proteid N. × 5.7).	Record number.	Percentage of— Proteid nitrogen in water-free material.	Percentage of— Proteids (proteid N. × 5.7).
232	3.11	17.73	309	3.74	21.36	386	2.52	15.07
233	3.31	18.92	310	3.15	18.01	387	2.73	15.59
234	3.23	18.43	311	2.99	17.07	388	3.05	17.41
235	3.65	20.82	312	3.48	19.88	389	2.95	16.87
236	3.18	18.17	313	3.52	20.11	390	3.22	18.36
237	4.87	27.79	314	3.16	18.03	391	3.26	18.60
238	2.69	15.38	315	2.75	15.68	392	2.93	16.74
239	2.59	14.77	316	3.35	19.13	393	2.70	15.41
240	3.52	20.12	317	3.42	19.54	394	2.77	15.81
241	2.76	15.75	318	2.01	11.50	395	2.98	16.99
242	2.96	16.89	319	2.86	16.33	396	2.28	13.02
243	3.47	19.78	320	2.98	17.00	397	....	....
244	3.30	18.83	321	3.42	19.54	398	....	....
245	3.64	20.77	322	2.54	14.53	399	3.09	17.65
246	3.75	21.39	323	3.42	19.54	400	3.35	19.12
247	3.50	19.95	324	3.18	18.16	401	3.36	19.20
248	3.64	20.78	325	3.45	19.70	402	2.32	13.26
249	3.21	18.32	326	....	....	403	3.03	17.31
250	3.11	17.76	327	3.44	19.64	404	3.30	18.83
251	3.46	19.73	328	3.60	20.55	405	3.75	21.43
252	2.54	14.52	329	2.87	16.39	406	2.43	13.90
253	3.63	20.71	330	2.61	14.93	407	3.79	21.63
254	....	....	331	....	....	408	3.63	20.74
255	3.02	17.26	332	2.57	14.68	409	3.59	20.47
256	3.31	18.88	333	3.25	18.56	410	3.26	18.63
257	....	....	334	2.61	14.92	411	3.15	17.95
258	3.37	19.24	335	2.81	15.70	412	3.63	20.70
259	3.84	21.89	336	3.35	19.11	413	3.77	21.51
260	1.93	11.03	337	2.88	16.45	414	3.13	17.89
261	3.49	19.92	338	4.95	28.23	415	2.44	13.93
262	3.19	18.21	339	3.33	19.01	416	3.23	18.44
263	3.24	18.48	340	2.73	15.61	417	3.79	21.65
264	3.36	19.20	341	2.97	16.94	418	3.05	17.39
265	3.29	18.80	342	2.60	14.82	419	2.85	16.28
266	3.10	17.70	343	2.50	14.27	420	3.73	21.27
267	3.18	18.18	344	2.93	16.71	421	2.53	14.45
268	4.10	23.39	345	2.55	14.57	422	3.53	20.12
269	3.20	18.29	346	2.55	14.55	423	3.14	17.90
270	3.36	19.19	347	2.44	13.92	424	2.61	14.93
271	3.39	19.34	348	2.87	16.39	425	3.29	18.81
272	3.13	17.88	349	2.65	15.18	426	3.08	17.60
273	3.39	19.78	350	2.63	15.03	427	3.06	17.46
274	3.56	20.34	351	3.31	18.90	428	2.59	14.80
275	3.32	18.96	352	3.04	17.38	429	3.03	17.31
276	3.15	17.95	353	3.10	17.72	430	2.81	16.06
277	2.85	16.26	354	2.72	15.53	431	3.20	18.25
278	3.11	17.77	355	2.83	16.18	432	3.00	17.11
279	3.78	21.60	356	2.91	16.61	433	3.12	17.80
280	3.70	21.10	357	2.36	13.47	434	2.85	16.28
281	3.26	18.60	358	2.33	13.60	435	3.53	20.14
282	3.01	17.19	359	2.97	16.95	436	2.88	16.44
283	3.85	22.00	360	2.88	16.45	437	3.12	17.82
284	3.71	21.20	361	2.94	16.77	438	2.66	15.20
285	3.87	22.07	362	3.03	17.28	439	2.98	16.99
286	3.55	20.26	363	3.49	19.89	440	2.35	13.44
287	3.86	22.04	364	2.91	16.62	441	2.93	16.72
288	2.82	16.09	365	3.49	19.94	442	3.22	17.98
289	2.52	14.40	366	3.16	18.04	443	2.50	14.30
290	4.00	22.81	367	3.37	19.23	444	2.37	13.56
291	2.23	12.73	368	3.06	17.47	445	2.37	13.51
292	4.15	23.68	369	3.33	19.02	446	3.75	21.37
293	2.63	15.04	370	3.09	17.64	447	2.86	16.33
294	2.56	14.60	371	2.98	17.04	448	3.13	16.67
295	3.05	17.41	372	3.30	18.84	449	2.76	15.76
296	3.93	22.44	373	2.86	16.33	450	3.61	20.62
297	1.99	11.35	374	3.15	17.97	451	2.92	16.68
298	....	....	375	3.40	19.89	452	3.17	18.07
299	3.67	20.96	376	2.59	14.76	453	3.15	17.96
300	3.06	17.49	377	3.46	19.76	454	3.14	17.92
301	3.08	17.61	378	2.74	15.65	455	2.62	14.95
302	2.68	15.28	379	3.09	17.64	456	2.71	15.47
303	....	....	380	2.35	13.42	457	3.14	17.92
304	2.23	12.74	381	3.45	19.67	458	3.18	18.20
305	3.07	17.52	382	3.22	18.40	459	2.60	14.84
306	2.50	14.30	383	2.96	16.88	460	3.91	22.29
307	3.19	18.20	384	3.55	20.26	461	....	....
308	2.84	16.22	385	3.79	21.62	462	2.39	13.64

TABLE 18.—*Variations in content of proteids*—Continued.

Record number.	Percentage of—		Record number.	Percentage of—		Record number.	Percentage of—	
	Proteid nitrogen in water-free material.	Proteids (proteid N. × 5.7).		Proteid nitrogen in water-free material.	Proteids (proteid N. × 5.7).		Proteid nitrogen in water-free material.	Proteids (proteid N. × 5.7).
463	2.49	14.24	540	3.17	18.12	617	3.12	17.83
464	1.98	11.29	541	3.09	17.66	618	2.67	15.27
465	3.32	18.97	542	3.33	19.01	619	3.59	20.49
466	2.98	17.01	543	3.50	19.96	620	2.68	15.30
467	2.89	16.48	544	1.29	7.37	621	2.24	12.79
468	2.95	16.82	545	2.10	11.98	622	3.19	18.23
469	2.74	15.62	546	2.54	14.49	623	3.52	20.09
470	2.80	15.97	547	2.73	15.59	624	2.67	15.27
471	2.24	12.79	548	3.01	17.21	625	2.68	15.30
472	2.49	14.22	549	2.50	14.30	626	2.69	15.38
473	2.76	15.78	550	2.84	16.20	627	2.88	16.44
474	2.80	15.97	551	2.99	17.08	628	3.68	21.01
475	2.95	16.83	552	2.30	13.11	629	3.47	19.82
476	2.52	14.39	553	3.21	18.35	630	2.48	14.16
477	2.95	16.85	554	2.91	16.59	631	3.39	19.35
478	3.15	18.00	555	3.16	18.06	632	3.22	18.41
479	2.27	12.96	556	3.02	17.26	633	1.64	9.38
480	2.72	15.53	557	3.30	18.86	634	2.10	11.99
481	3.04	17.38	558	3.25	18.58	635	3.42	19.52
482	3.15	17.97	559	2.94	16.78	636	3.08	17.61
483	2.60	14.86	560	3.32	18.93	637	2.77	15.79
484	3.45	19.71	561	3.00	17.13	638	3.54	20.21
485	2.59	14.81	562	1.12	6.40	639	3.15	18.00
486	2.68	15.31	563	2.36	13.49	640	2.82	16.10
487	3.01	17.18	564	3.83	21.84	641	3.37	19.26
488	2.41	13.77	565	....	....	642	2.57	14.68
489	3.45	19.70	566	3.49	19.49	643	3.35	19.14
490	2.46	14.02	567	3.08	17.57	644	3.41	19.47
491	2.87	16.40	568	2.17	12.39	645	2.44	13.91
492	2.06	11.78	569	3.03	17.29	646	3.77	21.54
493	3.18	18.16	570	3.20	18.27	647	2.82	16.08
494	2.45	13.97	571	2.52	14.37	648	2.53	14.47
495	2.36	13.45	572	3.12	17.82	649	2.56	14.63
496	2.52	14.38	573	2.52	14.41	650	2.59	14.82
497	2.84	16.21	574	3.25	18.53	651	....	....
498	2.82	16.08	575	3.17	18.10	652	2.83	16.19
499	2.97	16.95	576	2.52	14.40	653	2.50	14.31
500	3.06	17.48	577	3.09	17.61	654	2.59	14.81
501	2.64	15.09	578	2.73	15.60	655	3.21	18.30
502	2.72	15.56	579	3.35	19.10	656	2.56	14.61
503	2.31	13.19	580	....	....	657	2.55	14.57
504	3.06	17.48	581	3.79	21.61	658	....	....
505	2.71	15.46	582	2.59	14.77	659	2.92	16.70
506	2.49	14.24	583	3.13	17.86	660	3.26	18.60
507	3.13	17.85	584	3.49	19.91	661	2.55	14.56
508	2.89	16.51	585	3.05	17.40	662	2.50	14.26
509	3.20	18.29	586	3.27	18.65	663	2.82	16.11
510	2.93	16.71	587	2.56	14.60	664	2.80	15.98
511	3.61	20.59	588	2.83	16.17	665	3.33	19.01
512	2.71	15.45	589	2.84	16.20	666	2.35	13.40
513	2.86	16.33	590	2.86	16.31	667	2.31	13.20
514	2.41	13.79	591	3.06	17.44	668	2.50	14.30
515	2.27	12.98	592	3.20	18.29	669	4.36	24.86
516	3.28	18.75	593	2.88	16.47	670	6.33	36.12
517	2.36	13.49	594	3.32	18.93	671	2.32	13.23
518	3.64	20.75	595	3.18	18.17	672	4.82	28.15
519	2.81	16.03	596	3.09	17.66	673	3.39	19.35
520	2.54	14.48	597	3.32	18.93	674	3.24	18.48
521	2.68	15.28	598	2.34	13.39	675	3.41	19.44
522	3.12	17.79	599	3.12	17.81	676	3.11	17.73
523	2.99	17.05	600	2.97	16.97	677	2.51	14.36
524	1.93	11.04	601	2.08	11.91	678	3.09	17.65
525	2.51	14.35	602	3.64	20.77	679	2.48	14.17
526	1.71	9.79	603	2.56	14.62	680	2.30	13.13
527	3.15	17.99	604	2.53	14.45	681	3.36	19.17
528	2.35	13.42	605	2.56	14.60	682	2.49	14.20
529	2.88	16.44	606	3.13	17.85	683	2.70	15.41
530	2.64	15.06	607	3.01	17.20	684	3.59	20.51
531	2.97	16.94	608	3.05	17.41	685	4.04	23.06
532	2.75	15.73	609	2.75	15.72	686	2.79	15.90
533	3.22	18.37	610	3.51	20.05	687	2.83	16.13
534	2.95	16.82	611	3.00	17.15	688	2.65	15.12
535	3.03	17.29	612	3.26	18.62	689	2.68	15.28
536	2.57	14.66	613	3.84	21.92	690	3.38	19.26
537	2.88	16.47	614	2.77	15.79	691	3.04	17.33
538	2.64	15.09	615	2.72	15.52	692	2.81	16.04
539	3.76	21.46	616	3.72	21.22	693	2.35	13.76

TABLE 18.—*Variations in content of proteids*—Continued.

Record number.	Percentage of— Proteid nitrogen in water-free material.	Percentage of— Proteids (proteid N. × 5.7).	Record number.	Percentage of— Proteid nitrogen in water-free material.	Percentage of— Proteids (proteid N. × 5.7).	Record number.	Percentage of— Proteid nitrogen in water-free material.	Percentage of— Proteids (proteid N. × 5.7).
694	2.15	12.29	730	2.09	11.92	766	2.87	16.41
695	2.92	16.69	731	3.18	18.18	767	2.22	12.69
696	....	....	732	2.41	13.78	768	2.45	13.98
697	2.11	12.07	733	2.06	11.77	769	2.37	13.51
698	3.03	17.29	734	2.76	15.73	770	1.37	7.86
699	2.64	15.09	735	2.09	11.96	771	1.62	9.27
700	4.10	23.42	736	2.29	13.09	772	2.00	11.42
701	2.51	14.33	737	1.61	9.20	773	1.73	9.87
702	2.27	12.96	738	2.01	11.44	774	2.32	13.26
703	2.33	13.34	739	2.85	16.26	775	1.88	10.76
704	2.43	13.94	740	1.87	10.71	776	2.28	13.03
705	2.48	14.18	741	1.75	9.99	777	2.80	16.02
706	1.87	10.69	742	3.57	20.36	778	1.98	11.33
707	3.07	17.52	743	2.63	15.02	779	2.35	13.40
708	2.12	12.09	744	1.97	11.23	780	2.85	16.29
709	1.87	10.67	745	2.98	16.99	781	2.79	15.94
710	2.10	12.00	746	1.77	10.10	782	2.64	15.09
711	2.08	11.87	747	2.79	15.95	783	2.81	16.02
712	2.61	14.88	748	1.83	10.44	784	1.92	10.96
713	2.20	12.58	749	2.29	13.06	785	2.25	12.88
714	2.16	12.32	750	2.22	12.66	786	3.29	18.75
715	3.23	18.44	751	3.48	19.85	787	2.95	16.82
716	2.77	15.81	752	3.48	19.87	788	2.13	12.17
717	2.38	13.61	753	1.33	7.53	789	2.20	12.57
718	3.14	17.91	754	3.55	20.29	790	2.86	16.32
719	2.16	12.35	755	2.43	13.90	791	3.02	17.22
720	1.80	10.29	756	2.30	13.15	792	2.16	12.36
721	2.14	12.22	757	2.14	12.24	793	2.32	13.24
722	2.16	12.36	758	1.67	9.54	794	2.82	16.11
723	2.18	12.43	759	2.14	12.25	795	2.48	14.15
724	2.04	11.67	760	3.72	21.21	796	2.45	14.00
725	2.32	13.26	761	2.47	14.12	797	2.20	12.56
726	2.19	12.52	762	2.93	16.72	798	2.95	16.82
727	1.79	10.23	763	2.02	11.56	799	2.18	12.48
728	2.49	14.22	764	2.18	12.47	800	2.02	11.57
729	2.92	16.46	765	2.20	12.57			

It will be noticed that there is a very large range of variation in the proteid nitrogen content of these wheats, running from 1.12 to 4.95 per cent. By referring to Table 8, it will be seen that an equally large variation occurred between the plants when the whole plant was sampled. In the 351 analyses the nitrogen ranges from 1.20 to 5.85 per cent. This is due in the main to the ability of the plant to gather nitrogen from the soil. In no one of the experiments to ascertain the effect of nitrogenous manures on the composition of wheat has there been an increase of more than a few tenths of 1 per cent, even when the nitrogenous fertilizer was added to an exhausted soil. It is, therefore, not likely that such large variation in nitrogen content could be due to irregularities in the supply of soil nitrogen. If this ability of the plant to store up a large amount of nitrogen in the kernel is hereditary, as results given later indicate, there is ample opportunity to develop by selection a strain of wheat of high nitrogen content.

A BASIS FOR SELECTION TO INCREASE THE QUANTITY OF PROTEIDS IN THE ENDOSPERM OF THE KERNEL.

White bread flour, which constitutes the major portion of the wheat flour consumed in this country, is derived entirely from the endosperm of the wheat kernel. The portions of the kernel not entering into the flour are the germ and the seed coat, attached to each of which discarded constituents are portions of the endosperm. The larger part of the aleürone layer either adheres to the hull and constitutes the "bran" of commerce, or appears in the product known as "shorts," and sometimes in low-grade flour.

As it is the flour in which it is desired to increase the nitrogen, and as the flour consists entirely of the endosperm, it becomes desirable to have some way to determine the nitrogen content of the endosperm alone and to select for reproduction plants possessing a large amount of nitrogen in this portion of the kernel.

It is a question how this can best be done. A determination of gluten by the ordinary method of washing, to carry off the starch and fiber while the gluten is being worked in the hand, is not well adapted for use with the small quantities of wheat obtainable from a single plant. This also has the disadvantage that it gives no indication as to the quality of the gluten.

Determinations of gliadin and glutenin promise to be of some help in affording a basis for selection from individual plants. It has been shown by Osborne and Voorhees[a] that the gluten of wheat is composed of gliadin and glutenin. It does not necessarily follow, however, that the sum of these two substances is a measure of the gluten content of the sample analyzed. Osborne and Campbell[b] have stated that the embryo of the wheat kernel does not contain either gliadin or glutenin. This being the case, the sum of the gliadin and glutenin would represent these proteids in the endosperm, with, perhaps, a small amount in the hull.

A recent investigation by Nasmith[c] leads him to conclude that gliadin exists in all portions of the endosperm, including the aleurone layer, but that glutenin is contained only in the starch-bearing portion of the endosperm. A determination of glutenin may, therefore, give an indication of the gluten content of the wheat.

Table 19 shows the percentage of proteid nitrogen, the sum of the gliadin and glutenin nitrogen, the amounts in grams of proteid and of gliadin-plus-glutenin nitrogen in the average kernel, and the grams of proteid and of gliadin-plus-glutenin nitrogen in all of the kernels on each plant. The plants are grouped into those having

[a] American Chem. Jour., 1893, pp. 392–471.

[b] Connecticut Experiment Station Report, 1899, p. 305.

[c] Trans. Canad. Inst., 7 (1903), Univ. Toronto Studies, Physiol. Ser. (1903), No. 4.

from 1 to 2 per cent proteid nitrogen, those having 2 to 2.5 per cent proteid nitrogen, etc. Table 20 gives the averages for each of the groups in Table 19.

TABLE 19.—*Relation of gliadin-plus-glutenin nitrogen to proteid nitrogen.*

Record number.	Percentage of—		Number of kernels.	Weight (in grams) of—					
	Proteid nitrogen.	Gliadin-plus-glutenin nitrogen.		Kernels.	Average kernel.	Proteid nitrogen in kernels.	Gliadin-plus-glutenin nitrogen in kernels.	Proteid nitrogen in average kernel.	Gliadin-plus-glutenin nitrogen in average kernel.
1 TO 2 PER CENT PROTEID NITROGEN.									
55307	1.89	1.56	342	5.6864	0.01663	0.10747	0.08871	0.0003142	0.0002594
80305	1.81	1.77	729	15.7835	.02165	.28569	.27937	.0003919	.0003832
81705	1.98	1.96	465	9.7922	.02106	.19388	.19193	.0004170	.0004128
Average	1.89	1.76	512	10.4207	.01978	.19568	.18667	.0003744	.0003518
2 TO 2.5 PER CENT PROTEID NITROGEN.									
21212	2.16	0.19	84	1.7216	0.02049	0.03718	0.00327	0.0004427	0.0000389
27205	2.41	1.70	891	16.4061	.01841	.39539	.27890	.0004437	.0003130
27206	2.36	1.46	777	19.1854	.02469	.45276	.28010	.0005827	.0003605
27505	2.12	1.65	539	12.0399	.02183	.24942	.19866	.0004627	.0003602
33107	2.35	2.12	318	6.1026	.01919	.14341	.12643	.0004510	.0004163
33605	2.39	1.92	301	7.0596	.02345	.16872	.13554	.0005605	.0004502
39205	2.11	1.84	1,031	21.5399	.02089	.45435	.39635	.0004407	.0003844
48106	2.38	1.80	608	11.6655	.01919	.27765	.20997	.0004567	.0003454
48409	2.02	1.50	314	6.4302	.02048	.12989	.09645	.0004137	.0003072
55309	2.48	1.97	167	2.5160	.01507	.06240	.04957	.0003736	.0002969
55908	2.42	1.96	562	12.2210	.02175	.29575	.23953	.0005262	.0004263
55909	2.30	1.66	302	9.2120	.03050	.21187	.15292	.0007016	.0005063
56206	2.42	1.95	509	9.3093	.01829	.22529	.18153	.0004426	.0003566
56207	2.34	1.83	462	10.9073	.02361	.25522	.19960	.0005524	.0004321
57508	2.21	2.05	380	12.0728	.03177	.26680	.24750	.0007021	.0006513
65306	2.41	1.68	544	9.8298	.01807	.23690	.16514	.0004355	.0003036
65307	2.28	1.81	373	7.0051	.01878	.15971	.12680	.0004282	.0003399
65308	2.09	1.95	583	11.7066	.02008	.24468	.22828	.0004197	.0003916
74606	2.30	2.05	464	9.6451	.02079	.22184	.19772	.0004781	.0004262
81707	2.34	.64	786	18.3614	.02336	.42965	.11750	.0005466	.0001495
81708	2.41	1.64	287	7.3993	.02578	.17833	.12135	.0006213	.0004228
Average	2.30	1.68	489.6	10.5874	.02173	.24272	.17872	.0004991	.0003652
2.5 TO 3 PER CENT PROTEID NITROGEN.									
20706	2.78	2.05	163	3.3138	0.02033	0.09212	0.06793	0.0005652	0.0004168
20707	2.77	1.85	444	9.9070	.02282	.27443	.18328	.0006181	.0004222
20710	2.83	2.00	867	17.1115	.01974	.48428	.34222	.0005586	.0003948
21207	2.96	.17	118	2.3066	.01955	.06804	.00392	.0005766	.0000332
21305	2.67	1.97	313	6.2514	.02004	.16691	.12315	.0005353	.0003948
21306	2.90	.97	226	4.1516	.01837	.12039	.04027	.0005327	.0001782
21805	2.69	.23	1,232	20.9290	.01699	.56299	.04704	.0004569	.0000391
21807	2.73	2.11	377	9.4172	.02498	.25709	.19870	.0006664	.0005271
21808	2.57	1.96	1,156	19.7446	.01708	.50744	.38700	.0004389	.0003348
21809	2.73	2.18	418	8.0214	.01919	.21898	.17487	.0005238	.0004183
21905	2.64	2.18	791	14.3111	.01809	.37781	.31198	.0004777	.0003944
22205	2.81	1.97	283	2.6965	.00953	.07577	.05312	.0002677	.0001877
22207	2.77	1.82	169	3.2787	.01940	.09082	.05967	.0005374	.0003531
26905	2.76	2.09	326	6.4102	.01966	.17692	.13398	.0005427	.0004109
26906	2.71	1.82	228	4.2376	.01859	.11484	.07712	.0005037	.0003383
26908	2.96	2.16	192	3.9797	.02073	.11780	.08596	.0006135	.0004478
26909	2.80	1.88	180	2.9999	.01667	.08400	.05640	.0004667	.0003134
27005	2.63	1.90	866	16.4120	.01895	.43164	.31182	.0004984	.0003600
27207	2.92	1.95	166	3.3266	.02004	.09712	.06487	.0005850	.0003908
27305	2.58	1.73	267	5.5666	.02085	.14362	.09630	.0005379	.0003607
27307	2.53	.82	167	3.0850	.01847	.07805	.02530	.0004674	.0001515
27506	2.70	1.98	444	10.0005	.02252	.27003	.19800	.0006082	.0004459
27508	2.64	2.32	251	5.5[illegible]24	.02287	.14608	.12835	.0006037	.0005306
27509	2.90	1.09	243	5.3615	.02206	.15549	.05844	.0006399	.0002405

TABLE 19.—*Relation of gliadin-plus-glutenin nitrogen to proteid nitrogen*—Continued.

2.5 TO 3 PER CENT PROTEID NITROGEN—Continued.

Record number.	Percentage of—		Number of kernels.	Weight (in grams) of—					
	Proteid nitrogen.	Gliadin-plus-glutenin nitrogen.		Kernels.	Average kernel.	Proteid nitrogen in kernels.	Gliadin-plus-glutenin nitrogen in kernels.	Proteid nitrogen in average kernel.	Gliadin-plus-glutenin nitrogen in average kernel.
28805	2.91	1.55	87	2.1851	0.02512	0.06359	0.03387	0.0007309	0.0003894
33105	2.91	3.50	132	2.5601	.01939	.07450	.08960	.0005644	.0006787
37305	2.96	2.29	309	6.1394	.01987	.18173	.14060	.0005881	.0004550
37705	2.64	1.26	461	8.0905	.01972	.23998	.10194	.0005327	.0002485
37707	2.93	2.10	193	3.3004	.01710	.09670	.06931	.0005010	.0003591
38005	2.84	1.23	139	2.5134	.01808	.07138	.03091	.0005135	.0002224
38606	2.63	1.39	401	8.4605	.02110	.22251	.11760	.0005549	.0002933
38608	2.82	1.73	158	3.0228	.01913	.08522	.05229	.0005394	.0003309
38609	2.74	1.34	293	6.7665	.02309	.18540	.09067	.0006475	.0003094
39405	2.88	1.44	447	9.3541	.02093	.21399	.13470	.0006027	.0003014
39506	2.93	2.06	67	1.9218	.02869	.05631	.03959	.0008404	.0005910
40505	2.82	2.19	170	4.1546	.02444	.11716	.09099	.0006892	.0005352
43405	2.92	1.18	124	2.8000	.02258	.08176	.03304	.0006594	.0002664
44505	2.94	.70	340	5.9990	.01764	.17637	.04199	.0005187	.0001235
44606	2.90	1.29	124	2.5235	.02035	.07318	.03255	.0005902	.0002625
46107	2.54	2.08	478	8.3935	.01756	.21319	.17458	.0004460	.0003652
48305	2.87	1.77	473	12.0278	.02543	.34524	.21289	.0007299	.0004501
48806	2.70	.75	547	9.8346	.01798	.26553	.07376	.0004877	.0001348
55008	2.60	1.58	944	17.4226	.01846	.45299	.27528	.0004799	.0002917
55206	2.56	1.87	578	11.3592	.01965	.29079	.21241	.0005031	.0003675
55308	2.54	.65	397	9.5078	.02395	.24150	.06180	.0006225	.0001557
55506	2.80	2.20	866	17.8506	.02062	.49995	.39272	.0005773	.0004536
55507	2.63	2.07	504	9.8228	.01949	.25834	.20333	.0005126	.0004034
55605	2.64	1.96	500	10.9180	.02184	.28823	.21400	.0005765	.0004281
55606	2.58	1.49	503	11.0930	.02205	.28580	.16529	.0005690	.0002609
55905	2.67	1.75	331	5.7948	.01751	.15470	.10141	.0004674	.0003064
55906	2.81	1.47	499	7.9968	.01603	.22471	.11755	.0004503	.0002356
55907	2.59	1.61	749	19.3966	.02590	.50238	.31229	.0006707	.0004170
56105	2.73	2.12	336	5.7431	.01709	.15679	.12175	.0004667	.0003622
56106	2.57	2.09	644	12.0161	.01866	.30881	.25174	.0004795	.0003900
56107	2.96	2.23	872	14.4556	.01658	.42790	.32236	.0004907	.0003697
56205	2.51	1.85	333	6.5232	.01959	.16373	.12068	.0004917	.0003624
56208	2.61	1.95	563	13.5720	.02356	.34616	.26465	.0006149	.0004594
56209	2.59	2.21	950	15.8086	.01664	.40945	.34937	.0004310	.0003677
57007	2.65	2.09	88	1.5364	.01746	.04164	.03211	.0004731	.0003649
57406	2.75	2.13	135	2.4923	.01846	.06854	.05309	.0005077	.0003932
57407	2.62	1.86	762	14.9992	.01968	.39297	.27898	.0005157	.0003660
57408	2.61	1.64	596	12.2004	.02047	.31842	.20008	.0005343	.0003557
57506	2.80	2.34	180	2.7616	.01534	.07733	.06462	.0004296	.0003590
57507	2.85	1.55	359	6.9861	.01946	.19905	.10828	.0005545	.0003016
57805	2.87	2.68	270	4.8988	.01814	.14060	.13126	.0005207	.0004861
58805	2.74	2.11	1,158	23.1471	.01999	.63422	.48839	.0005464	.0004218
63106	2.79	2.20	165	3.3006	.02001	.09208	.07261	.0005581	.0004402
66005	2.63	2.18	370	7.6690	.02073	.02017	.16714	.0005451	.0004519
81505	2.94	2.65	146	2.8327	.01940	.08328	.07507	.0005704	.0005141
81706	2.71	2.03	722	15.3928	.02132	.41715	.31248	.0005778	.0004328
Average	2.74	1.79	419.3	8.2271	.01991	.22222	.14658	.0005468	.0003557

3 TO 3.5 PER CENT PROTEID NITROGEN.

20709	3.05	2.31	258	5.3229	0.02063	0.16235	0.12296	0.0006292	0.0004766
20805	3.32	2.26	697	14.6942	.02157	.48784	.33208	.0006999	.0004875
21205	3.16	.22	123	2.3642	.01922	.07471	.00520	.0006074	.0000423
21208	3.24	2.15	287	5.1594	.01798	.16712	.11093	.0005824	.0003866
21307	3.04	.46	143	2.5691	.01796	.07810	.01182	.0005461	.0000826
21906	3.18	2.10	408	10.4800	.02563	.33402	.22008	.0008168	.0005382
21907	3.35	2.15	158	2.9248	.01851	.09798	.06288	.0006201	.0003980
22206	3.22	2.11	146	2.5712	.01720	.08086	.05425	.0005538	.0003629
22208	3.18	2.14	118	1.9090	.01619	.06071	.04084	.0005144	.0003465
22210	3.17	1.55	298	6.0173	.02019	.19075	.09327	.0006401	.0003129
22211	3.17	1.69	561	11.5675	.02062	.36671	.19548	.0006537	.0003485
26808	3.09	2.28	222	3.8811	.01748	.11992	.08849	.0005402	.0003985
28206	3.07	2.42	219	4.3698	.01996	.13415	.10575	.0006126	.0004830
28806	3.02	1.86	685	14.4630	.02111	.43679	.26901	.0006376	.0003926
33305	3.41	2.41	150	3.1346	.02090	.10689	.07554	.0007126	.0005037
33607	3.22	2.45	136	2.8903	.02125	.09307	.07081	.0006843	.0005206
48306	3.29	2.13	157	2.6571	.01692	.08742	.05660	.0005568	.0003604
48506	3.20	2.17	556	9.4585	.01701	.30267	.20525	.0005444	.0003691

TABLE 19.—*Relation of gliadin-plus-glutenin nitrogen to proteid nitrogen*—Continued.

3 TO 3.5 PER CENT PROTEID NITROGEN—Continued.

Record number.	Percentage of—		Number of kernels.	Weight (in grams) of—					
	Proteid nitrogen.	Gliadin-plus-glutenin nitrogen.		Kernels.	Average kernel.	Proteid nitrogen in kernels.	Gliadin-plus-glutenin nitrogen in kernels.	Proteid nitrogen in average kernel.	Gliadin-plus-glutenin nitrogen in average kernel.
48705	3.13	1.56	264	4.3615	0.01652	0.13652	0.06804	0.0005171	0.0002577
48706	3.00	.71	379	6.1983	.01635	.18596	.04401	.0004906	.0001161
55005	3.05	1.99	393	7.9684	.02028	.24303	.15857	.0006185	.0004036
55006	3.16	1.75	451	7.1852	.01593	.22705	.12574	.0005034	.0002788
55508	3.11	1.96	216	3.7407	.01732	.11636	.07332	.0005386	.0003395
57905	3.18	2.92	221	2.4731	.01118	.07859	.07221	.0003556	.0003264
58207	3.09	2.49	307	4.2207	.01375	.13042	.10510	.0004248	.0003424
58705	3.01	2.47	235	2.5436	.01082	.07656	.06283	.0003258	.0002673
Average	3.16	1.95	299.5	5.5817	.01817	.17602	.10889	.0005741	.0003516

3.5 TO 4 PER CENT PROTEID NITROGEN.

17506	3.52	2.23	93	2.2881	0.02460	0.08044	0.05102	0.0008660	0.0005486
18905	3.81	1.54	103	1.4864	.01443	.05663	.03315	.0005498	.0003218
21811	3.75	2.16	567	11.9114	.02101	.44666	.25728	.0007877	.0004538
21908	3.82	1.88	173	3.5574	.02056	.13589	.06688	.0007855	.0003955
26107	3.92	1.35	144	2.0390	.01416	.07993	.02753	.0005551	.0001912
38505	3.61	1.77	563	12.1088	.02252	.43713	.21432	.0007764	.0003986
42205	3.63	2.73	94	1.8494	.01967	.06713	.05049	.0007142	.0005370
45005	3.58	1.36	235	3.2340	.01376	.11575	.04398	.0004927	.0001871
48505	3.66	1.76	137	1.9154	.01398	.07010	.03371	.0005117	.0002460
66006	3.54	1.38	366	6.0090	.01642	.21272	.08292	.0005812	.0002266
Average	3.68	1.82	247.5	4.6399	.01811	.17024	.08613	.0006620	.0003506

4 TO 4.5 PER CENT PROTEID NITROGEN.

21812	4.26	2.02	983	14.8137	0.01507	0.63107	0.29934	0.0006420	0.0003044
21813	4.04	2.14	216	4.0258	.01877	.16377	.08615	.0007582	.0004017
21909	4.43	1.98	525	12.1819	.02317	.53889	.29846	.0010265	.0005677
34405	4.33	2.44	207	4.1281	.01994	.17875	.10073	.0008635	.0004865
55007	4.21	2.21	118	2.1571	.01828	.09082	.04767	.0007696	.0004040
76206	4.45	2.03	447	5.4411	.01217	.24213	.11046	.0005417	.0002471
Average	4.29	2.14	416	7.1230	.01790	.30757	.15714	.0007669	.0004019

MORE THAN 4.5 PER CENT PROTEID NITROGEN.

21206	5.23	0.22	149	2.8564	0.01917	0.14939	0.00628	0.0010026	0.0000422
21210	5.03	1.34	237	3.9143	.01577	.19689	.05245	.0007934	.0002113
40205	4.69	3.07	194	3.6302	.01871	.17026	.11145	.0008776	.0005744
48406	4.87	2.25	249	3.2964	.01324	.16053	.08168	.0006447	.0002979
69805	5.82	1.94	110	2.4420	.02220	.14213	.04738	.0012921	.0004307
72607	5.59	2.51	188	3.4442	.01832	.19253	.08645	.0010241	.0004598
92306	4.93	4.06	347	6.0091	.01732	.29625	.24397	.0008539	.0007032
Average	5.16	2.198	210.6	3.6561	.01782	.18685	.08995	.0009269	.0003885

TABLE 20.—*Summary of analyses, showing relation of gliadin-plus-glutenin nitrogen to proteid nitrogen.*

Range of percentage of proteid nitrogen.	Number of analyses.	Percentage of— Proteid nitrogen.	Percentage of— Gliadin-plus-glutenin nitrogen.	Number of kernels.	Weight (in grams) of— Kernels.	Average kernel.	Proteid nitrogen in kernels.	Gliadin-plus-glutenin nitrogen in kernels.	Proteid nitrogen in average kernel.	Gliadin-plus-glutenin nitrogen in average kernel.
1 to 2	3	1.89	1.76	512.0	10.4207	0.01978	0.19568	0.18667	0.0003744	0.0003518
2 to 2.5	21	2.30	1.68	489.6	10.5874	.02173	.24272	.17872	.0004991	.0003652
2.5 to 3	70	2.74	1.73	419.3	8.2271	.01991	.22222	.13948	.0005468	.0003442
3 to 3.5	26	3.16	1.95	299.5	5.5817	.01817	.17602	.10889	.0005741	.0003516
3.5 to 4	10	3.68	1.82	247.5	4.6399	.01811	.17024	.08613	.0006620	.0003506
4 to 4.5	6	4.29	2.22	416.0	7.1230	.01790	.30757	.15714	.0007669	.0004019
4.5 and over	7	5.16	2.20	210.6	3.6561	.01782	.18685	.08995	.0009269	.0003886

The figures in Table 20 show that while gliadin-plus-glutenin nitrogen increases with proteid nitrogen it does not do so in the same ratio, the increase in proteid nitrogen being due in large measure to an increase in other proteids.

The same analyses are tabulated in Table 21 according to the increase in gliadin-plus-glutenin nitrogen, and the averages for each group are stated in Table 22. In the latter table the increase in proteid nitrogen does not keep pace with the increase in gliadin-plus-glutenin nitrogen, there being 1.74 per cent other proteid nitrogen in the first group and 1.25 per cent in the last.

It thus becomes evident that a determination of proteid nitrogen in the kernel is not an accurate guide to the content of gliadin plus glutenin, and that a direct determination of these substances is necessary.

It is, furthermore, apparent that a determination of gliadin-plus-glutenin nitrogen will permit of the selection of kernels having a large percentage of these substances.

TABLE 21.—*Relation of proteid nitrogen to gliadin-plus-glutenin nitrogen.*

GLIADIN-PLUS-GLUTENIN NITROGEN, 1 TO 1.5 PER CENT.

Record number.	Percentage of— Gliadin-plus-glutenin nitrogen.	Percentage of— Proteid nitrogen.	Number of kernels.	Weight (in grams) of— Kernels.	Average kernel.	Gliadin plus-glutenin nitrogen in kernels.	Proteid nitrogen in kernels.	Gliadin-plus-glutenin nitrogen in average kernel.	Proteid nitrogen in average kernel.
21210	1.34	5.03	237	3.9143	0.01575	0.05245	0.19689	0.0002113	0.0007934
26107	1.35	3.92	144	2.0390	.01416	.02753	.07993	.0001912	.0005551
27206	1.46	2.36	777	19.1854	.02469	.28010	.45276	.0003605	.0005827
27509	1.09	2.90	243	5.3615	.02206	.05844	.15549	.0002405	.0006399
37705	1.26	2.64	461	8.0905	.01972	.10194	.23998	.0002485	.0005327
38005	1.23	2.84	139	2.5134	.01808	.03091	.07138	.0002224	.0005135
38606	1.39	2.63	401	8.4605	.02110	.11760	.22251	.0002933	.0005549
38609	1.34	2.74	293	6.7665	.02309	.09067	.18540	.0003094	.0006479
39405	1.44	2.88	447	9.3541	.02093	.13470	.21399	.0003014	.0006027
43405	1.18	2.92	124	2.8000	.02258	.03304	.08176	.0002664	.0006594
44606	1.29	2.90	124	2.5235	.02035	.03255	.07318	.0002625	.0005902
45005	1.36	3.58	235	3.2340	.01376	.04398	.11575	.0001871	.0004927
55606	1.49	2.58	505	11.0930	.02205	.16529	.28580	.0002609	.0005690
55906	1.47	2.81	499	7.9968	.01603	.11755	.22471	.0002356	.0004503
66006	1.38	3.54	366	6.0090	.01642	.08292	.21272	.0002266	.0005812
Average	1.34	3.08	333	6.6228	.01939	.09198	.18748	.0002545	.0005843

TABLE 21.—*Relation of proteid nitrogen to gliadin-plus-glutenin nitrogen*—Continued.

GLIADIN-PLUS-GLUTENIN NITROGEN, 1.5 TO 2 PER CENT.

Record number.	Percentage of— Gliadin-plus-glutenin nitrogen.	Proteid nitrogen.	Number of kernels.	Weight (in grams) of— Kernels.	Average kernel.	Gliadin-plus-glutenin nitrogen in kernels.	Proteid nitrogen in kernels.	Gliadin-plus-glutenin nitrogen in average kernel.	Proteid nitrogen in average kernel.
18905	1.54	3.81	103	1.4864	0.01443	0.03315	0.05663	0.0003218	0.0005498
20707	1.85	2.77	444	9.9070	.02282	.18328	.27443	.0004222	.0006181
21305	1.97	2.67	312	6.2514	.02004	.12315	.16691	.0003948	.0005350
21808	1.96	2.57	1,156	19.7446	.01708	.38700	.50744	.0003348	.0004389
21908	1.88	3.82	173	3.5574	.02056	.06688	.13589	.0003955	.0007855
21909	1.98	4.43	525	12.1819	.02317	.29846	.53889	.0005677	.0010265
22205	1.97	2.81	283	2.6965	.00953	.05312	.07577	.0001877	.0002677
22207	1.82	2.77	169	3.2787	.01940	.05967	.09082	.0003531	.0005376
22210	1.55	3.17	298	6.0173	.02019	.09327	.19075	.0003129	.0006401
22211	1.69	3.17	561	11.5675	.02062	.19548	.36671	.0003485	.0006537
26906	1.82	2.71	228	4.2376	.01859	.07712	.11484	.0003383	.0005037
26909	1.88	2.80	180	2.9999	.01667	.05640	.08400	.0003134	.0004667
27005	1.90	2.63	866	16.4120	.01895	.31182	.43164	.0003600	.0004984
27205	1.70	2.41	891	16.4061	.01841	.27890	.39539	.0003130	.0004437
27207	1.95	2.92	166	3.3266	.02004	.06487	.09712	.0003908	.0005850
27305	1.73	2.58	267	5.5666	.02085	.09630	.14362	.0003607	.0005379
27505	1.65	2.12	539	12.0399	.02183	.19866	.24942	.0003602	.0004627
27506	1.98	2.70	444	10.0005	.02252	.19800	.27003	.0004459	.0006082
28805	1.55	2.91	87	2.1851	.02572	.03887	.06359	.0003894	.0007309
28806	1.86	3.02	685	14.4630	.02111	.26901	.43679	.0003926	.0006376
33605	1.92	2.39	301	7.0596	.02345	.13554	.16872	.0001502	.0005605
38505	1.77	3.61	563	12.1088	.02252	.21432	.43713	.0003986	.0007764
38608	1.73	2.82	158	3.0228	.01913	.05229	.08522	.0003309	.0005394
39205	1.84	2.11	1,031	21.5399	.02089	.39635	.45435	.0003844	.0004407
48106	1.80	2.38	608	11.6655	.01919	.20997	.27765	.0003454	.0004567
48305	1.77	2.87	473	12.0278	.02543	.21289	.34524	.0004501	.0007299
48409	1.50	2.02	314	6.4302	.02048	.09645	.12989	.0003072	.0004137
48505	1.76	3.66	137	1.9154	.01398	.03371	.07010	.0002460	.0005117
48705	1.56	3.13	264	4.3615	.01652	.06804	.13652	.0002577	.0005171
55005	1.99	3.05	393	7.9684	.02028	.15857	.24303	.0004036	.0006185
55006	1.75	3.16	451	7.1852	.01593	.12574	.22705	.0002788	.0005034
55008	1.58	2.60	944	17.4226	.01846	.27528	.45299	.0002917	.0004799
55206	1.87	2.57	578	11.3592	.01965	.21241	.29079	.0003675	.0005031
55305	1.97	2.48	167	2.5160	.01507	.04957	.06240	.0002969	.0003736
55307	1.56	1.89	342	5.6864	.01663	.08871	.10747	.0002599	.0003142
55508	1.96	3.11	216	3.7407	.01732	.07332	.11636	.0003395	.0005386
55605	1.96	2.64	500	10.9180	.02184	.21400	.28823	.0004281	.0005765
55905	1.75	2.67	331	5.7948	.01751	.10141	.15470	.0003064	.0004674
55907	1.61	2.59	749	19.3966	.02590	.31229	.50238	.0004170	.0006707
55908	1.96	2.42	562	12.2210	.02175	.23953	.29575	.0004263	.0005262
55909	1.66	2.30	302	9.2120	.03050	.15292	.21187	.0005063	.0007016
56205	1.85	2.51	333	6.5232	.01959	.12068	.16373	.0003624	.0004917
56206	1.95	2.42	509	9.3093	.01829	.18153	.22529	.0003566	.0004426
56207	1.83	2.34	462	10.9073	.03361	.19960	.25522	.0004321	.0005524
56208	1.95	2.61	563	13.5720	.02356	.26465	.34616	.0004594	.0006149
57407	1.86	2.62	762	14.9992	.01968	.27898	.39297	.0003660	.0005157
57408	1.64	2.61	596	12.2004	.02047	.20008	.31842	.0003357	.0005343
57507	1.55	2.85	359	6.9861	.01946	.10828	.19905	.0003016	.0005545
65306	1.68	2.41	544	9.8298	.01807	.16514	.23690	.0003036	.0004355
65307	1.81	2.28	373	7.0051	.01878	.12680	.15971	.0003399	.0004282
65308	1.95	2.09	583	11.7066	.02008	.22828	.24468	.0003916	.0004197
69805	1.94	5.82	110	2.4420	.02220	.04738	.14213	.0004307	.0002921
80305	1.76	1.81	729	15.7835	.02165	.27937	.28569	.0003832	.0003919
81705	1.96	1.98	465	9.7922	.02106	.19193	.19388	.0004128	.0004170
81708	1.64	2.41	287	7.3993	.02578	.12135	.17833	.0004228	.0006213
Average	1.80	2.76	442.5	9.0243	.02016	.16392	.23801	.0003653	.0005538

GLIADIN-PLUS-GLUTENIN NITROGEN, 2 TO 2.5 PER CENT.

17506	2.23	3.52	93	2.2881	0.02460	0.05102	0.08044	0.0005486	0.0008660
20706	2.05	2.78	163	3.3138	.02033	.06793	.09212	.0004168	.0005652
20709	2.31	3.05	258	5.3229	.02063	.12296	.16235	.0004766	.0006292
20710	2.00	2.83	867	17.1115	.01974	.34222	.48428	.0003948	.0005586
20805	2.26	3.32	697	14.6942	.02157	.33208	.48784	.0004875	.0006999
21208	2.15	3.24	287	5.1594	.01798	.11093	.16712	.0003866	.0005824
21807	2.11	2.73	377	9.4172	.02498	.19870	.25709	.0005271	.0006664
21809	2.18	2.73	418	8.0214	.01919	.17487	.21898	.0004183	.0005238
21811	2.16	3.75	567	11.9114	.02101	.25728	.44666	.0004538	.0007877
21812	2.02	4.26	983	14.8139	.01507	.29934	.63107	.0003044	.0006420
21813	2.14	4.04	216	4.0258	.01877	.08615	.16377	.0004017	.0007582
21905	2.18	2.64	791	14.3111	.01809	.31198	.37781	.0003944	.0004777

TABLE 21.—*Relation of proteid nitrogen to gliadin-plus-glutenin nitrogen*—Continued.

GLIADIN-PLUS-GLUTENIN NITROGEN, 2 TO 2.5 PER CENT—Continued.

Record number.	Percentage of—		Number of kernels.	Weight (in grams) of—					
	Gliadin-plus-glutenin nitrogen.	Proteid nitrogen.		Kernels.	Average kernel.	Gliadin-plus-glutenin nitrogen in kernels.	Proteid nitrogen in kernels.	Gliadin-plus-glutenin nitrogen in average kernel.	Proteid nitrogen in average kernel.
21906	2.10	3.18	408	10.4800	0.02563	0.22008	0.33403	0.0005382	0.0008168
21907	2.15	3.35	158	2.9248	.01851	.06288	.09798	.0003980	.0006201
22206	2.11	3.22	146	2.5712	.01720	.05425	.08086	.0003629	.0005538
22208	2.14	3.10	118	1.9090	.01619	.04084	.06071	.0003465	.0005144
26808	2.28	3.09	222	3.8811	.01748	.08849	.11992	.0003985	.0005402
26905	2.09	2.76	326	6.4102	.01966	.13398	.17692	.0004109	.0005427
26908	2.16	2.96	192	3.9797	.02073	.08596	.11780	.0004478	.0006135
27508	2.32	2.64	251	5.5324	.02287	.12835	.14608	.0005306	.0006037
28206	2.42	3.07	219	4.3698	.01996	.10575	.13415	.0004830	.0006126
33107	2.12	2.35	318	6.1026	.01919	.12643	.14341	.0004163	.0004510
33305	2.41	3.41	150	3.1346	.02090	.07554	.10689	.0005037	.0007126
33607	2.45	3.22	136	2.8902	.02125	.07081	.09307	.0005206	.0006843
34405	2.44	4.33	207	4.1281	.01994	.10073	.17875	.0004865	.0008635
37305	2.29	2.96	309	6.1394	.01987	.14060	.18173	.0004550	.0005881
37707	2.10	2.93	193	3.3004	.01710	.06931	.09670	.0003591	.0005010
39506	2.06	2.93	67	1.9218	.02869	.03959	.05631	.0005910	.0008404
40505	2.19	2.82	170	4.1546	.02444	.09099	.11716	.0005352	.0006892
46107	2.08	2.54	478	8.3935	.01756	.17458	.21319	.0003652	.0004460
48306	2.13	3.29	157	2.6571	.01692	.05660	.08742	.0003604	.0005568
48406	2.25	4.87	249	3.2964	.01324	.08168	.16053	.0002979	.0006447
48506	2.17	3.20	556	9.4585	.01701	.20525	.30267	.0003691	.0005444
55007	2.21	4.21	118	2.1571	.01828	.04767	.09082	.0004040	.0007696
55506	2.20	2.80	866	17.8506	.02062	.39272	.49995	.0004536	.0005773
55507	2.07	2.63	504	9.8228	.01949	.20333	.25834	.0004034	.0005126
56105	2.12	2.73	336	5.7431	.01709	.03503	.15679	.0001042	.0004667
56106	2.09	2.57	644	12.0161	.01866	.05768	.30881	.0000896	.0004795
56107	2.23	2.96	872	14.4556	.01658	.10553	.42792	.0001210	.0004907
56209	2.21	2.59	950	15.8086	.01664	.34937	.40945	.0003677	.0004310
57007	2.09	2.65	168	1.5364	.01746	.03211	.04164	.0003649	.0004731
57406	2.13	2.75	135	2.4923	.01846	.05309	.06854	.0003932	.0005077
57506	2.34	2.80	180	2.7616	.01534	.06462	.07733	.0003590	.0004296
57508	2.05	2.21	380	12.0728	.03177	.24750	.26680	.0006513	.0007021
58207	2.49	3.09	307	4.2207	.01375	.10510	.13042	.0003424	.0004248
58705	2.47	3.01	235	2.5436	.01082	.06283	.07656	.0002673	.0003258
58805	2.11	2.74	1,158	23.1471	.01999	.48839	.63422	.0004218	.0005464
63106	2.20	2.79	165	3.3006	.02001	.07261	.09208	.0004402	.0005581
66005	2.18	2.63	370	7.6690	.02073	.16714	.20170	.0004519	.0005451
74606	2.05	2.30	464	9.6451	.02079	.19772	.22184	.0004262	.0004781
76206	2.03	4.45	447	5.4411	.01217	.11046	.24213	.0002471	.0005417
81706	2.03	2.71	722	15.3928	.02132	.31248	.41715	.0004328	.0005778
Average	2.18	3.08	380.1	7.2520	.01935	.14641	.21535	.0004063	.0005872

GLIADIN-PLUS-GLUTENIN NITROGEN, 2.5 TO 3 PER CENT.

42205	2.73	3.63	94	1.8494	0.01967	0.050049	0.06713	0.0005370	0.0007142
57805	2.68	2.87	270	4.8988	.01814	.13126	.14060	.0004861	.0005207
57905	2.92	3.18	221	2.4731	.01118	.07221	.07859	.0003264	.0003556
72607	2.51	5.59	188	3.4442	.01832	.08645	.19253	.0004598	.0010241
81505	2.65	2.94	146	2.8327	.01940	.7507	.08328	.0005141	.0005704
Average	2.698	3.64	183.8	3.0696	.01734	.08310	.11243	.0004647	.0006370

GLIADIN-PLUS-GLUTENIN NITROGEN, 3 PER CENT AND OVER.

40205	3.07	4.69	194	3.6302	0.01871	0.11145	0.17026	0.0005744	0.0008776
92306	4.06	4.93	347	6.0091	.01732	.24397	.29625	.0007032	.0008539
Average	3.56	4.81	270.5	4.8196	.01801	.17771	.23325	.0006388	.0008657

TABLE 22.—*Summary of analyses, showing relation of proteid nitrogen to gliadin-plus-glutenin nitrogen.*

Range of percentage of gliadin-plus-glutenin nitrogen.	Percentage of—		Number of—		Weight (in grams) of—					
	Gliadin-plus-glutenin nitrogen.	Proteid nitrogen.	Analyses.	Kernels.	Kernels.	Average kernel.	Gliadin-plus-glutenin nitrogen in kernels.	Proteid nitrogen in kernels.	Gliadin-plus-glutenin nitrogen in average kernel.	Proteid nitrogen in average kernel.
1 to 1.5	1.34	3.08	15	333	6.6228	0.01939	0.09198	0.18748	0.0002545	0.0005843
1.5 to 2	1.80	2.76	55	442.5	9.0243	.02016	.16392	.23801	.0003653	.0005538
2 to 2.5	2.18	3.08	52	380.1	7.2520	.01935	.14641	.21535	.0004063	.0005872
2.5 to 3	2.70	3.64	5	183.8	3.0696	.01734	.08310	.11243	.0004647	.0006370
3 and over	3.56	4.81	2	270.5	4.8196	.01801	.17771	.23325	.0006388	.0008657

IMPROVEMENT IN THE QUALITY OF THE GLUTEN.

It is well known that large differences exist in the bread-making values of different varieties of wheats even when they have approximately the same gluten content and are raised in the same locality. This fact is generally attributed to differences in the quality of the gluten.

W. Farrar[a] points out the difference in the bread-making qualities of two wheats due to the quality of the gluten. He compares Saxon Fife wheat, which had a gluten content of 9.92 per cent, and which produced 309 pounds of bread from 200 pounds of flour, with Purple Straw Tuscan wheat, which had a gluten content of 9.94 per cent, and which produced only 278 pounds of bread from the same quantity of flour.

In this case it was not the amount but the quality of the gluten that determined the greater excellence of the Saxon Fife wheat.

It has further been stated by Girard,[b] Snyder,[c] and Guthrie[d] that the ratio in which gliadin and glutenin exist in the gluten determines its value for bread making.

It was considered desirable to ascertain whether the proportions of these two constituents remain about the same in wheats of high and of low content. If the quality of the gluten remains constant as the quantity increases, the value of the wheat for bread making will improve in about the same ratio. If, on the other hand, there is a tendency for the quality to deteriorate as the quantity increases, there would be greater difficulty in effecting improvement.

In Table 23, analyses of the crop of 1903 are arranged in groups according to their content of gliadin plus glutenin. The first group comprises all plants having less than 1 per cent, and each succeeding group increases by 0.25 per cent. It is followed by Table 24, which is a summary of Table 23.

[a] Agricultural Gazette of New South Wales, 9 (1898), pp. 241–250.

[b] Compt. Rend., 1897, p. 876.

[c] Minnesota Experiment Station Bulletins 54 and 63.

[d] Agricultural Gazette of New South Wales, 9 (1898), pp. 363–374.

TABLE 23.—*Ratio of gliadin to glutenin as the content of their sum increases.*

GLIADIN-PLUS-GLUTENIN NITROGEN, BELOW 1 PER CENT.

Record number.	Percentage of—			Proportion of—		Percentage of—	
	Gliadin-plus-glutenin nitrogen.	Gliadin nitrogen.	Glutenin nitrogen.	Gliadin.	Glutenin.	Proteid nitrogen.	Other proteid nitrogen.
21205	0.216	0.114	0.102	0.528	0.472	3.16	2.944
21206	.218	.142	.076	.651	.349	5.23	5.012
21207	.170	.099	.071	.582	.418	2.96	2.790
21212	.192	.109	.083	.567	.433	2.16	1.968
21306	.975	.505	.470	.518	.482	2.90	1.925
21307	.461	.255	.206	.447	.553	3.04	2.579
21805	.230	.126	.104	.548	.452	2.69	2.460
27307	.821	.806	.015	.982	.018	2.53	1.709
48806	.748	.018	.730	.024	.976	2.70	1.952
55308	.655	.629	.026	.960	.040	2.54	1.885
81707	.636	.237	.399	.372	.628	2.34	1.704
Average	.484	.276	.208	.562	.438	2.93	2.448

GLIADIN-PLUS-GLUTENIN NITROGEN, 1 TO 1.25 PER CENT.

27509	1.087	1.072	0.015	0.986	0.014	2.90	1.813
38005	1.227	.593	.634	.483	.517	2.84	1.613
43405	1.184	1.078	.106	.910	.090	2.92	1.736
Average	1.166	.914	.252	.793	.207	2.89	1.721

GLIADIN-PLUS-GLUTENIN NITROGEN, 1.25 TO 1.50 PER CENT.

26107	1.352	0.108	1.244	0.080	0.920	3.92	2.568
27206	1.465	.815	.650	.556	.444	2.36	.895
37705	1.265	.715	.550	.565	.435	2.64	1.375
38606	1.387	.725	.662	.522	.478	2.63	1.243
38609	1.336	.586	.750	.439	.561	2.74	1.404
39405	1.439	.818	.621	.568	.432	2.88	1.441
44606	1.287	1.057	.230	.821	.179	2.90	1.613
45005	1.361	1.240	.121	.911	.089	3.58	2.219
55606	1.493	.899	.594	.602	.398	2.58	1.087
55906	1.470	.443	1.027	.301	.699	2.81	1.340
Average	1.385	.741	.645	.536	.463	2.90	1.518

GLIADIN-PLUS-GLUTENIN NITROGEN, 1.50 TO 1.75 PER CENT.

18905	1.537	0.143	1.394	0.093	0.907	3.81	2.273
22210	1.555	.801	.754	.515	.485	3.17	1.615
22211	1.692	1.002	.690	.592	.408	3.17	1.478
27205	1.700	1.073	.627	.631	.369	2.41	.710
27305	1.735	1.075	.660	.619	.381	2.58	.845
27505	1.651	1.032	.619	.625	.375	2.12	.469
28805	1.555	.958	.597	.616	.384	2.91	1.355
38608	1.731	.962	.769	.556	.444	2.82	1.089
48409	1.504	.690	.814	.459	.541	2.02	.516
48705	1.563	.057	1.506	.036	.964	3.13	1.567
55008	1.581	.687	.894	.435	.565	2.60	1.019
55307	1.561	.908	.653	.582	.418	1.89	.329
55907	1.608	.632	.976	.393	.607	2.59	.982
55909	1.658	.810	.848	.488	.512	2.30	.642
57408	1.639	1.177	.462	.717	.283	2.61	.971
57507	1.546	1.141	.405	.738	.262	2.85	1.304
65306	1.683	.965	.718	.573	.427	2.41	.727
81708	1.641	1.221	.420	.744	.256	2.41	.769
Average	1.619	.852	.767	.523	.477	2.65	1.037

TABLE 23.—*Ratio of gliadin to glutenin as the content of their sum increases*—Continued.

GLIADIN-PLUS-GLUTENIN NITROGEN, 1.75 TO 2 PER CENT.

Record number.	Percentage of—			Proportion of—		Percentage of—	
	Gliadin-plus-glutenin nitrogen.	Gliadin nitrogen.	Glutenin nitrogen.	Gliadin.	Glutenin.	Proteid nitrogen.	Other proteid nitrogen.
20707	1.855	1.046	0.809	0.564	0.436	2.77	0.915
20710	1.996	1.125	.871	.564	.436	2.83	.834
21305	1.969	1.049	.920	.533	.467	2.67	.701
21808	1.963	1.046	.917	.533	.467	2.57	.607
21908	1.876	1.015	.861	.541	.459	3.82	1.944
21909	1.976	1.367	.609	.697	.303	4.43	2.454
22205	1.969	1.185	.784	.602	.398	2.81	.841
26906	1.819	.988	.831	.543	.457	2.71	.891
26909	1.879	.996	.883	.531	.469	2.80	.921
27005	1.904	1.066	.838	.559	.441	2.63	.726
27207	1.946	1.278	.668	.652	.348	2.92	.974
27506	1.977	1.147	.830	.580	.420	2.70	.723
28806	1.864	.902	.962	.484	.516	3.02	1.156
33605	1.919	1.124	.795	.585	.415	2.39	.471
38505	1.766	.862	.904	.488	.512	3.61	1.844
39205	1.845	1.117	.728	.605	.395	2.11	.265
48106	1.805	1.035	.770	.573	.427	2.38	.575
48305	1.766	.996	.770	.564	.436	2.87	1.104
48505	1.757	.965	.792	.549	.451	3.66	1.903
55005	1.987	1.102	.885	.555	.445	3.05	1.063
55006	1.754	1.099	.655	.626	.374	3.16	1.406
55206	1.866	.840	1.026	.450	.550	2.56	.694
55305	1.974	1.042	.932	.528	.472	2.48	.506
55508	1.959	1.037	.922	.529	.471	3.11	1.151
55605	1.959	1.044	.915	.533	.467	2.64	.681
55905	1.750	.575	1.175	.328	.672	2.67	.920
55908	1.957	1.075	.882	.549	.451	2.42	.463
56205	1.850	.883	.967	.477	.523	2.51	.660
56206	1.949	1.089	.860	.559	.441	2.42	.471
56207	1.827	.987	.840	.540	.460	2.34	.513
56208	1.946	1.127	.819	.579	.421	2.61	.664
57407	1.858	.935	.923	.503	.497	2.62	.762
65307	1.815	1.052	.763	.579	.421	2.28	.465
65308	1.946	1.090	.856	.560	.440	2.09	.144
69805	1.937	1.142	.795	.589	.411	5.82	3.883
80305	1.770	1.159	.611	.661	.339	1.81	.040
81705	1.956	1.048	.908	.535	.465	1.98	.024
Average	1.889	1.044	.845	.552	.448	2.82	.929

GLIADIN-PLUS-GLUTENIN NITROGEN, 2 TO 2.25 PER CENT.

17506	2.226	1.458	0.768	0.655	0.345	3.52	1.294
20706	2.053	1.089	.964	.530	.470	2.78	.727
21208	2.146	1.154	.992	.537	.463	3.24	1.094
21807	2.110	1.174	.936	.556	.444	2.73	.620
21809	2.178	1.183	.995	.543	.457	2.73	.552
21811	2.156	1.144	1.012	.531	.469	3.75	1.594
21812	2.023	1.139	.884	.563	.437	4.26	2.237
21813	2.141	1.045	1.096	.488	.512	4.04	1.899
21905	2.181	1.344	.837	.616	.384	2.64	.459
21906	2.096	1.208	.888	.576	.424	3.18	1.084
21907	2.146	1.187	.959	.553	.447	3.35	1.204
22206	2.113	1.271	.842	.601	.399	3.22	1.107
22208	2.142	1.309	.833	.611	.389	3.18	1.038
26905	2.087	1.197	.890	.573	.427	2.76	.673
26908	2.158	1.250	.908	.579	.421	2.96	.802
33107	2.123	1.283	.840	.604	.396	2.35	.227
37707	2.097	1.044	1.053	.498	.502	2.93	.833
39506	2.065	1.281	.784	.620	.380	2.93	.865
40505	2.189	1.143	1.046	.522	.478	2.82	.631
46107	2.076	1.164	.912	.561	.439	2.54	.464
48306	2.135	1.130	1.005	.529	.471	3.29	1.155
48406	2.249	1.290	.959	.574	.426	4.87	2.621
48506	2.171	1.104	1.067	.508	.492	3.20	1.029
55007	2.211	1.248	.963	.564	.436	4.21	1.999
55506	2.197	1.136	1.061	.517	.483	2.80	.603
55507	2.070	1.079	.991	.521	.479	2.63	.560
56105	2.118	1.277	.841	.603	.397	2.73	.612
56106	2.091	1.091	1.000	.522	.478	2.57	.479
56107	2.234	1.033	1.201	.462	.538	2.96	.726
56209	2.208	1.161	1.047	.526	.474	2.59	.382

TABLE 23.—*Ratio of gliadin to glutenin as the content of their sum increases*—Continued.

GLIADIN-PLUS-GLUTENIN NITROGEN, 2 TO 2.25 PER CENT—Continued.

Record number.	Percentage of—			Proportion of—		Percentage of—	
	Gliadin-plus-glutenin nitrogen.	Gliadin nitrogen.	Glutenin nitrogen.	Gliadin.	Glutenin.	Proteid nitrogen.	Other proteid nitrogen.
57007	2.093	1.159	0.934	0.553	0.447	2.65	0.557
57406	2.134	1.080	1.054	.506	.494	2.75	.616
57508	2.053	1.124	.929	.547	.453	2.21	.157
58805	2.112	1.060	1.052	.501	.499	2.74	.628
63106	2.199	1.186	1.013	.539	.461	2.79	.591
66005	2.181	1.142	1.039	.528	.472	2.63	.449
74606	2.046	1.016	1.030	.496	.504	2.30	.254
76206	2.029	1.223	.806	.602	.398	4.45	2.421
81706	2.034	1.701	.333	.816	.184	2.71	.676
Average	2.130	1.187	.943	.557	.443	3.05	.921

GLIADIN-PLUS-GLUTENIN NITROGEN, 2.25 TO 2.50 PER CENT.

20709	2.313	1.307	1.006	0.565	0.435	3.05	0.737
20805	2.259	1.215	1.044	.538	.462	3.32	1.061
26808	2.281	1.377	.904	.604	.396	3.09	.809
27508	2.324	1.247	1.077	.537	.463	2.64	.316
28206	2.424	1.366	1.058	.563	.437	3.07	.646
33305	2.407	1.182	1.225	.491	.509	3.41	1.003
33607	2.446	1.391	1.055	.569	.431	3.22	.774
34405	2.443	1.230	1.213	.503	.497	4.33	1.887
37305	2.293	1.208	1.085	.527	.473	2.96	.667
57506	2.344	1.203	1.141	.511	.489	2.80	.456
58207	2.492	1.313	1.179	.526	.474	3.09	.598
58705	2.467	1.195	1.272	.484	.516	3.01	.543
Average	2.374	1.268	1.105	.535	.465	3.16	.791

GLIADIN-PLUS-GLUTENIN NITROGEN, 2.50 PER CENT AND OVER.

40205	3.069	1.850	1.219	0.603	0.397	4.69	1.621
42205	2.728	1.480	1.248	.542	.458	3.63	.902
57805	2.684	1.303	1.381	.485	.515	2.87	.186
57905	2.918	1.573	1.345	.539	.461	3.18	.262
72607	2.515	1.459	1.056	.579	.421	5.59	3.075
81505	2.652	1.066	1.586	.401	.599	2.94	.288
92306	4.063	2.388	1.675	.587	.413	4.93	.867
Average	2.947	1.588	1.358	.534	.466	3.98	1.029

TABLE 24.—*Summary of analyses, showing the ratio of gliadin to glutenin as the content of their sum increases.*

Range of percentage of gliadin-plus-glutenin nitrogen.	Percentage of gliadin-plus-glutenin nitrogen.	Number of analyses.	Percentage of—		Proportion of—		Percentage of—	
			Gliadin nitrogen.	Glutenin nitrogen.	Gliadin.	Glutenin.	Proteid nitrogen.	Other proteid nitrogen.
Below 1	0.484	11	0.276	0.208	0.562	0.438	2.93	2.448
1 to 1.25	1.166	3	.914	.252	.793	.207	2.89	1.721
1 25 to 1.50	1.385	10	.741	.645	.536	.463	2.90	1.518
1.50 to 1.75	1.619	18	.852	.767	.523	.477	2.65	1.037
1.75 to 2	1.889	37	1.044	.845	.552	.448	2.82	.929
2 to 2.25	2.130	39	1.187	.943	.557	.443	3.05	.921
2.25 to 2.50	2.374	12	1.268	1.105	.535	.465	3.16	.791
2.50 and over	2.947	7	1.588	1.358	.534	.466	3.98	1.029

It will be seen from Table 24 that the ratio of gliadin to glutenin remains practically the same as the percentage of their sum increases. It would therefore be safe to assume that an increase in the gluten

content of a given variety of wheat raised in the same region would carry with it a corresponding improvement in its value for bread making, although there might be fluctuations from year to year in quality of gluten, as there is in the quantity.

If the quality of gluten is determined by the ratio of gliadin and glutenin of which it is composed, it is likely that there is some certain proportion that is most desirable. Unfortunately, the investigators who have taken up this subject do not by any means agree upon the proper ratio. Should this be ascertained there would be ample opportunity for the selection of individual plants in which the proportion of gliadin and glutenin would approximate the ideal. There would thus be possible a much more rapid improvement in the quality of wheat than can be accomplished by confining selection to an increase in the gluten.

An obstacle to the usefulness of these determinations in the whole wheat appears in the announcement by Nasmith, already cited, that while gliadin occurs in all portions of the endosperm, glutenin does not appear in the aleurone cells. That being the case, it is difficult to believe that any given ratio between these constituents in the whole wheat could be taken as the one most desirable. The ratio in the gluten alone may, however, have an important influence on its quality, and a certain definite proportion of each may produce an ideal gluten.

In the light of the present knowledge on the subject, a mechanical determination of gluten would seem to be most useful, if it can be made with such small quantities of wheat as are obtained from single plants, while determinations of gliadin and glutenin in the gluten would afford a means of judging of its quality.

SOME RESULTS OF BREEDING TO INCREASE THE CONTENT OF PROTEID NITROGEN.

Selected plants have been grown on a large scale for two years. From these results it is very apparent that a high percentage of nitrogen and the qualities that go with it are transmissible from one generation to another.

In Table 25 are analyses of the plants of the crop of 1902, grouped according to their proteid nitrogen content into classes of from 1 to 2 per cent, 2 to 2.5 per cent, and increasing by 0.5 per cent up to 4.5 per cent and above. Opposite the plant number of each plant of the crop of 1902 are stated its percentage of proteid nitrogen and weight of proteid nitrogen in kernels. On the same line are the plant numbers for the entire progeny in 1903, and following these are the percentage of proteid nitrogen, weight of proteid nitrogen per average kernel, and average weight of kernel for all of these progeny.

The averages for each group are given in Table 26.

TABLE 25.—*Analyses showing transmission of nitrogen from one generation to another.*[a]

1 TO 2 PER CENT PROTEID NITROGEN.

1902				1903			
Record number.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in average kernel (gram).	Weight of average kernel (gram).	Record number.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in average kernel (gram).	Weight of average kernel (gram).
32201	1.51			32206–7	2.64	0.0010055	0.03874
32601	1.99			32605–6 and 8	2.62	.0015963	.07560
63501	1.98			63505–6	2.17	.0007499	.03502
69501	1.94			69505–6	2.39	.0009348	.03894
69701	1.97			69705	2.50	.0003874	.01550
73301	1.12			73306–8	2.586	.0016918	.06582
91901	1.83			91905–6	3.09	.0010830	.03513
92401	1.33			92405–9	2.628	.0024129	.09109
92901	1.67			92905–9	2.814	.0024540	.08814
94101	1.38			94105	2.67	.0006790	.02543
94201	1.63			94205–9	2.576	.0022132	.08738
94401	1.73			94406–7	2.27	.0008092	.03538
94601	1.89			91605–6	1.87	.0016125	.08851
94901	1.99			94905–9	2.85	.0025361	.08899
95501	1.92			95505–10	2.498	.0026506	.10605
Average	1.658			Average	2.587	.0004960	.019907

a In this table the average percentage of proteid nitrogen for all plants raised in 1903, resulting from plants of 1 to 2 per cent, 2 to 2.5 per cent, etc., in 1902 is determined by adding together analyses of all plants in that group and dividing by the total number, irrespective of families.

2 TO 2.5 PER CENT PROTEID NITROGEN.

17401	2.45			1740[5–6] [8–10]	2.646	0.0025803	0.09807
34201	2.28			34205–8	2.857	.0023077	.08075
57301	2.33	0.000601	0.02585	57305–8	2.54	.0018351	.07010
Average	2.353	.000601	.02585	Average	2.68	.00051716	.019146

2.5 TO 3 PER CENT PROTEID NITROGEN.

21701	2.50			21705–11	2.78	0.0042343	0.15101
33401	2.73			33405–8	1.977	.0014277	.07274
Average	2.615			Average	2.487	.0005147	.02032

3 TO 3.5 PER CENT PROTEID NITROGEN.

17301	3.04			17305–8	3.207	0.0025519	0.07920
17501	3.14			17505–7	4.006	.0021778	.05595
18901	3.31			18905–6	3.64	.0010439	.02863
20701	3.22			20705–10	2.86	.0034181	.12074
20801	3.49			20805	3.32	.0006999	.02157
21301	3.05			21305–8	3.015	.0021798	.07278
21801	3.10			21805–13	3.13	.0054513	.17668
21901	3.17			2190[5–9] [11–13]	3.527	.0060008	.16783
26901	3.28			26905–9	2.768	.0025943	.09357
27001	3.24			27005	2.63	.0004984	.01895
27201	3.12			27205–7	2.56	.0016114	.06314
27301	3.00			27305–8	2.93	.0022229	.07654
28801	3.31			28805–6	2.96	.0013685	.04623
33101	3.06			33105–7	2.73	.0015199	.05574
33301	3.33			33305	3.41	.0007126	.02090
33601	3.22			33605–7	2.606	.0017186	.06614
34401	3.08	0.000909	0.02956	34405	4.33	.0008635	.01994
34601	3.46	.000948	.02749	34606	3.12	.0006904	.02213
36901	3.18	.000827	.02602	36905	3.88	.0007295	.01880
37301	3.13	.000854	.02731	37305	2.96	.0005881	.01987
37701	3.44	.000685	.01995	37705–7	2.636	.0015390	.05837
37901	3.21	.000831	.02599	37905–6	2.48	.0009112	.03641
38501	3.09	.000844	.02732	38505–6	3.25	.0013476	.04227
38701	3.33	.000693	.02081	38706	2.59	.0005148	.01988
39401	3.31	.000933	.02820	39405	2.88	.0006027	.02093
40201	3.11	.001017	.03271	40205	4.69	.0008776	.01871
40301	3.11	.000914	.02942	40305	3.11	.0006255	.02011

TABLE 25.—*Analyses showing transmission of nitrogen from one generation to another*—Continued.

3 TO 3.5 PER CENT PROTEID NITROGEN—Continued.

1902				1903			
Record number.	Percentage of proteid nitrogen in kernel.	Proteid nitrogen in average kernel (gram).	Weight of average kernel (gram).	Record number.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in average kernel (gram).	Weight of average kernel (gram).
40401	3.32	0.001039	0.03136	40405	3.17	0.0004352	0.01373
40501	3.23	.001050	.03250	40505	2.82	.0006892	.02444
42201	3.46	.000972	.02813	42205–6	2.54	.0008988	.03231
42901	3.37	.000933	.02766	42905	3.17	.0005447	.01866
43401	3.24	.000907	.02800	43405	2.92	.0006594	.02258
43501	3.37	.000772	.02299	43505	4.13	.0006423	.01555
44601	3.33	.000899	.02701	44605–7	2.73	.0016171	.05890
48101	3.16	.000853	.02704	48106	2.38	.0004567	.01919
48301	3.49	.001005	.02882	48305–6	3.08	.0012867	.01235
48501	3.16	.000866	.02748	48505–8	3.065	.0021750	.07253
48701	3.36	.000820	.02445	48705–6	3.06	.0010077	.03287
48801	3.43	.000888	.02595	48806	2.70	.0004877	.01798
49501	3.19	.000791	.02488	49505	3.24	.0006149	.01898
50701	3.36	.000937	.02797	50705–6	3.17	.0010793	.03329
51001	3.33	.000789	.02377	51005	1.34	.0002422	.01804
55001	3.09	.000902	.02928	55005–8	3.255	.0023714	.07295
55201	3.45	.000928	.02697	55205–6	2.83	.0010373	.03688
55301	3.25	.000859	.02661	55305–8	2.27	.0017313	.07496
55901	3.05	.000930	.03052	55905–9	2.558	.0028162	.11169
56101	3.22	.000805	.02507	56105–7	2.75	.0014369	.05233
56201	3.26	.000808	.02485	56205–9	2.495	.0025326	.10169
57001	3.10	.000787	.02548	57005–7	2.706	.0013974	.05174
57101	3.35	.000958	.02860	57105	2.76	.0002527	.00916
57401	3.31	.000894	.02941	57405–8	2.49	.0019599	.07892
57501	3.30	.000785	.02381	57506–9	2.60	.0021279	.08396
58201	3.15	.000781	.02485	58206–7	2.88	.0006767	.02318
58501	3.14	.000832	.02665	58505	2.95	.0008052	.02730
58701	3.23	.000920	.02846	58705	3.01	.0003258	.01082
58901	3.05	.000723	.02379	58905	2.43	.0003292	.01355
59601	3.30	.000990	.03000	59605–6	2.14	.0007684	.03592
62801	3.14	....	....	62805	3.25	.0003938	.01212
65301	3.15	....	....	65305–8	2.925	.0024199	.08003
66001	3.46	....	....	66005–6, 8	3.25	.0017773	.05529
69301	3.12	....	....	69305	4.42	.0008767	.01984
69801	3.16	....	....	69805–6	3.74	.0016495	.04373
71901	3.02	....	....	71905	2.47	.0005531	.02239
72401	3.22	....	....	72405–6	3.155	.0019005	.05892
72601	3.17	....	....	72605–7	4.04	.0021643	.05274
72701	3.03	....	....	72705–8	2.937	.0026515	.08981
72801	3.31	....	....	72806	3.01	.0005738	.01906
72901	3.26	....	....	72905	2.48	.0003930	.01585
74301	3.13	....	....	74305	1.98	.0004054	.02047
74501	3.25	....	....	74506–8	2.78	.0014234	.05084
74601	3.17	....	....	74605–7	2.486	.0013768	.05562
76201	3.06	....	....	76205–6	3.40	.0009400	.02912
80301	3.23	....	....	80305	1.81	.0003919	.02165
81401	3.36	....	....	81405–6	2.965	.0010576	.03583
81501	3.42	....	....	81505	2.94	.0005704	.01940
84401	3.39	....	....	84405	2.48	.0005067	.02043
84901	3.10	....	....	84905–6	2.875	.0011244	.03902
85201	3.36	....	....	85205–6	2.63	.0007556	.02937
86101	3.38	....	....	86105–6	2.595	.0008522	.03244
88601	3.24	....	....	88605–9	2.566	.0026832	.11179
88901	3.14	....	....	88905–6	2.74	.0009933	.03625
92201	3.48	....	....	92205–8	2.67	.0020214	.07575
92301	3.49	....	....	92305–6	3.93	.0012908	.03223
95701	3.29	....	....	95705–7	2.58	.0013009	.05017
Average	3.239	.000875	.02700	Average	2.932	.00056037	.019189

3.5 TO 4 PER CENT PROTEID NITROGEN.

18801	3.55	....	....	18805	2.02	0.0003164	0.01567
21201	3.50	....	....	21205–12	3.567	.0054768	.15672
22201	3.65	....	....	22205–11	3.165	.0037042	.11711
25201	3.63	....	....	25205–6	2.735	.0011894	.04347
26101	3.76	....	....	26105–7	3.19	.0015273	.05113
27501	3.58	....	....	27505–9	2.688	.0028791	.10761

TABLE 25.—*Analyses showing transmission of nitrogen from one generation to another*—Continued.

3.5 TO 4 PER CENT PROTEID NITROGEN—Continued.

1902				1903			
Record number.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in average kernel (gram).	Weight of average kernel (gram).	Record number.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in average kernel (gram).	Weight of average kernel (gram).
33901	3.59	....	....	33905-6	2.21	0.0008932	0.04115
38001	3.82	0.000806	0.02110	38005	2.84	.0005135	.01808
38601	3.79	.001046	.02765	38605-9	3.718	.0036318	.09917
39201	3.98	.001039	.02616	39205	2.11	.0004407	.02089
39501	3.65	.001048	.02877	39506-7	2.975	.0013536	.04568
39601	3.55	.000927	.02619	39606	2.37	.0003177	.01341
42401	3.63	.001327	.02838	42405	3.07	.0006927	.02251
44501	3.57	.000796	.02531	44505	2.94	.0005187	.01764
45001	3.79	.001020	.02690	45005	3.58	.0004927	.01376
45601	3.87	.001238	.03205	45605-6	2.365	.0006777	.02995
45701	3.55	.000865	.02435	45705	4.18	.0007155	.01712
45801	3.87	.001146	.02963	45805	1.84	.0002700	.01234
48401	3.53	.000993	.02822	48405-9	2.90	.0020794	.07511
49901	3.61	.001043	.02898	49905	3.62	.0010640	.02939
55501	3.55	.001020	.02866	55506-8	2.846	.0016285	.05743
55601	3.79	.001050	.02775	55605-8	2.555	.0022356	.08822
57601	3.76	.001030	.02750	57606-8	2.37	.0015451	.06535
57801	3.80	.000891	.02353	57805	2.87	.0005207	.01814
57901	3.64	.000852	.02348	57905	3.18	.0003556	.01118
58801	3.80	.000904	.02384	58805-6	2.31	.0009317	.04048
60601	3.53	.000759	.02155	60605	1.87	.0003180	.01701
63101	3.91	....	....	63105-7	2.82	.0016570	.05951
81701	3.78	....	....	81705-10	2.27	.0031019	.13635
91301	3.57	....	....	91305	3.21	.0007197	.02242
92501	3.56	....	....	92505-7	3.32	.0017483	.05312
Average	3.68	.000990	.02650	Average	2.906	.0005508	.019204

4 TO 4.5 PER CENT PROTEID NITROGEN.

26801	4.07	....	....	26805-8	2.825	0.0023073	0.08179
28201	4.30	....	....	28206	3.07	.0006126	.01996
46101	4.00	0.000988	0.02472	46105-7	2.69	.0014772	.05495
Average	4.123	.000988	.02472	Average	2.806	.0005496	.019588

MORE THAN 4.5 PER CENT PROTEID NITROGEN.

50901	4.95	0.001074	0.02171	50905-6	3.435	0.0008992	0.02001
Average	....	....	....	Average	3.435	.0004496	.010005

TABLE 26.—*Summary of analyses, showing transmission of nitrogen from one generation to another.*

Range of percentage of proteid nitrogen.	1902				1903			
	Percentage of proteid nitrogen in kernels.	Number of analyses.	Proteid nitrogen in average kernel (gram).	Weight of average kernel (gram).	Percentage of proteid nitrogen in kernels.	Number of analyses.	Proteid nitrogen in average kernel (gram).	Weight of average kernel (gram).
1 to 2	1.66	15	....	....	2.59	46	0.0004960	0.01991
2 to 2.5	2.35	3	0.000601	0.02585	2.68	13	.0005172	.01915
2.5 to 3	2.61	2	....	....	2.49	11	.0005147	.02032
3 to 3.5	3.24	84	.000875	.02700	2.93	199	.0005604	.01919
3.5 to 4	3.68	31	.000990	.02650	2.91	79	.0005508	.01920
4 to 4.5	4.12	3	.000988	.02472	2.81	8	.0005496	.01959
4.5 and over	4.95	1	.001074	.02171	3.43	2	.0004496	.01000

In Table 26 the averages for each group are stated. This table is designed to show whether there has been a tendency for plants of a certain class to reproduce the qualities pertaining to that class, or whether these are lost in the offspring.

It is unfortunate that there are not a greater number of analyses of plants of medium and of low nitrogen content. The plants selected for reproduction in 1903 were largely those of high nitrogen content, and, consequently, comparatively few analyses of the low nitrogen and medium nitrogen plants of 1903 are at hand.

Table 25 shows that in the main there is a tendency for each class of plants to reproduce in the same relation to the other classes, but that there is less difference between the extreme classes in the offspring than in the parent plants. In other words, while all plants tend to reproduce their own qualities, those plants varying widely from the average produce, in general, offspring varying from the average less widely than did the parents. Although this is a rule, its application to the individual is not universal. Certain plants may be found whose tendency to variation extends through both generations. There is also wide variation between certain plants of the same parent. For instance, the plants numbered from 21205 to 21212, all of which come from the same parent, vary from 2.16 to 5.23 per cent in proteid nitrogen content, while plants 69805 and 69806 vary from 5.82 to 1.66 per cent in this constituent.[a]

It would seem, therefore, entirely reasonable to believe that a very considerable increase in the proteid nitrogen content of wheat may be effected by careful and continuous reproduction from plants of high proteid nitrogen content.

Table 27 contains the analyses of plants raised in 1902 and their progeny raised in 1903, arranged according to the number of grams of proteid nitrogen contained in the average kernel of the former.

TABLE 27.—*Analyses showing transmission of proteid nitrogen in average kernel.*

Range of proteid nitrogen in average kernel (gram).	1902				1903			
	Proteid nitrogen in average kernel (gram).	Number of analyses.	Percentage of proteid nitrogen in kernels.	Weight of average kernel (gram).	Proteid nitrogen in average kernel (gram).	Number of analyses.	Percentage of proteid nitrogen in kernels.	Weight of average kernel (gram).
0.000600 to 0.000700	0.000659	3	3.03	0.02220	0.000496	8	2.59	0.01895
0.000700 to 0.000800	.000776	9	3.29	.02405	.000444	15	2.68	.01673
0.000800 to 0.000900	.000850	18	3.33	.02576	.000544	38	2.91	.01875
0.000900 to 0.001000	.000938	18	3.37	.02796	.000514	35	2.89	.01784
0.001000 and over	.001077	15	3.71	.02880	.000593	28	3.06	.01905

[a] Table 25 represents the properties of each plant grown in 1903 arranged according to immediate families. For instance, plants numbered 17305–17308 are all the offspring of the same plant grown in 1902. The parent bears the number 17301. This is the system of records devised by Prof. W. M. Hays, formerly of the University of Minnesota.

TABLE 28.—*Analyses showing transmission of kernel weight.*

Range of weight of average kernel (gram).	1902				1903			
	Weight of average kernel (gram).	Number of analyses.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in average kernel (gram).	Weight of average kernel (gram).	Number of analyses.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in average kernel (gram).
Below 0.024	0.02253	12	3.61	0.000811	0.01684	19	2.69	0.000450
0.024 to 0.026	.02515	12	3.28	.000813	.01740	28	2.88	.000503
0.026 to 0.028	.02709	18	3.43	.000927	.01947	38	2.91	.000562
0.028 to 0.030	.02878	16	3.41	.000993	.01875	31	2.98	.000573
0.030 and over	.03152	6	3.31	.001044	.01869	12	2.96	.000548

Table 28 shows the analyses of plants raised in 1902 and their progeny raised in 1903, arranged according to weight of average kernel. There is more variation in this table than in the preceding one, but the tendency toward transmission of proteid nitrogen in the average kernel may be noted. The averages for 1902 are much higher than for 1903, owing partly to the higher percentage and partly to greater kernel weight.

The weight of the average kernel shows some tendency toward transmission, although there are some variations. It will be noticed that the kernels average much heavier in 1902 than in 1903, and that in spite of this the percentage of proteid nitrogen is higher in 1902. The relation of light kernel and high percentage of nitrogen does not therefore appear to hold as between crops of different years.

All of the qualities of which determinations have been made in both years appear to be transmitted. It may be safely assumed that certain plants will have greater power to transmit these qualities than will the average plant. Such plants will assert themselves in the course of three or four generations. From these plants individuals may be selected that have a combination of the desired qualities.

YIELD OF GRAIN AS AFFECTED BY SUSCEPTIBILITY TO COLD.

As has already been stated, a large number of plants on the breeding plots were killed during the winter of 1902–3. This afforded an opportunity to ascertain the effect of the severe weather upon the surviving plants. The question arose whether the surviving plants of a family of which a large percentage of members were killed yielded less per plant than the plants of a family of which but a small percentage had succumbed. As each spike of the crop of 1902 was represented by a number of plants, and as records of each plant were available, there were very extensive data at hand from which to secure information on the subject.

In Table 29 the surviving plants of each immediate family, or, in other words, the surviving plants descended from the same plant of the previous year, are classified according to the percentage of plants that survived the winter. Thus all plants of which only from 10 to 20

per cent survived are grouped together. In the next class are all plants of which from 20 to 30 per cent survived. The other classes increase by 10 per cent surviving plants until 70 per cent is reached. All plants of which more than 70 per cent survived form the last class.

Table 30 gives a summary of Table 29, the averages for each class being shown. From this table it will be seen that with an increase in the proportion of surviving plants there is an increase in the weight of grain per plant and in the number of kernels per plant. It is therefore to be concluded that decrease in yield from winter-killing is due not only to the loss of plants that are destroyed, but also to a decreased yield from most of the surviving plants.

Table 30 also shows that the weight of the average kernel is not affected by the freezing of a large proportion of the family, the decreased yield being due, it may be assumed, to the decreased number of kernels, owing to a decreased ability to tiller.

With an increase in the proportion of surviving plants there is, perhaps, a slight decrease in the percentage of proteid nitrogen in the kernels and in the number of grams of proteid nitrogen in the average kernel, although this is so slight and so irregular that it would not be safe to draw any conclusions from it. The total production of proteid nitrogen per plant naturally increases.

TABLE 29.—*Yields of plants, arranged according to percentage killed in each family.*

10 TO 20 PER CENT.

Record number for 1902.	Percentage of plants in 1903 surviving from 1902.	Weight of kernels on plant (gram).	Number of kernels.	Weight of average kernel (gram).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in kernels (gram).	Proteid nitrogen in average kernel (gram).
18801	11.1	2.1462	137	0.01567	2.02	0.04335	0.0003164
20801	10.0	14.6942	697	.02157	3.32	.48784	.0006999
25201	18.2	7.7295	363	.02173	2.73	.20732	.0005947
33301	16.7	2.9905	156	.01858	2.73	.07566	.0005066
37301	16.7	6.1394	309	.01987	2.96	.18173	.0005881
38001	14.3	2.5134	139	.01808	2.84	.07138	.0005135
39201	16.7	21.5399	1,031	.02089	2.11	.45435	.0004407
39401	16.7	9.3541	447	.02093	2.88	.21399	.0006027
40201	14.3	3.6302	194	.01871	4.69	.17026	.0008776
40401	16.7	.6316	46	.01373	3.17	.02002	.0004352
42901	16.7	1.2499	67	.01866	3.17	.03650	.0005447
43401	16.7	2.8000	124	.02258	2.92	.08176	.0006594
44501	16.7	5.9990	340	.01764	2.94	.17637	.0005187
45001	16.7	3.2340	235	.01376	3.58	.11575	.0004927
45701	14.3	.7532	44	.01712	4.18	.03148	.0007155
45801	16.7	1.5298	124	.01234	1.84	.02815	.0002700
49501	14.3	1.2716	67	.01898	3.24	.04120	.0006149
49901	14.3	.6760	23	.02939	3.62	.02436	.0010640
51001	16.7	15.5835	862	.01804	1.34	.20881	.0002422
57101	16.7	3.7263	407	.00916	2.76	.10285	.0002527
58501	16.7	7.4516	273	.02730	2.95	.21982	.0008052
58701	16.7	2.5436	235	.01082	3.01	.07656	.0003258
58901	16.7	2.3031	170	.01355	2.43	.05596	.0003292
60601	16.7	.5952	35	.01701	1.87	.01113	.0003180
62801	16.7	1.3451	111	.01212	3.25	.04272	.0003938
69301	16.7	2.0430	103	.01984	4.42	.09030	.0008767
74301	16.7	4.4222	216	.02047	1.98	.08756	.0004054
84401	16.7	8.7448	428	.02043	2.48	.21687	.0005067
91301	14.3	3.0940	138	.02242	3.21	.09932	.0007197
94101	14.3	.5595	22	.02543	2.67	.01494	.0006790
Average	15.78	4.7098	251.4	.01856	2.91	.12294	.00051366

TABLE 29.—*Yields of plants, arranged according to percentage killed in each family*—Cont'd.

20 TO 30 PER CENT.

Record number for 1902.	Percentage of plants in 1903 surviving from 1902.	Weight of kernels on plant (gram).	Number of kernels.	Weight of average kernel (gram).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in kernels (gram).	Proteid nitrogen in average kernel (gram).
18901	20.0	1.2046	84	0.01431	3.64	0.04437	0.0005219
27001	20.0	16.4120	866	.01895	2.63	.43164	.0004984
34601	28.6	6.1962	280	.02213	3.12	.19332	.0006904
36901	20.0	5.0200	267	.01880	3.88	.19478	.0007295
39601	28.6	4.6383	346	.01341	2.37	.10967	.0003177
40301	25.0	3.6003	179	.02011	3.11	.11197	.0006255
40501	20.0	4.1546	170	.02444	2.82	.11716	.0006892
42201	25.0	1.0827	59	.01615	2.54	.03587	.0004494
42401	20.0	1.4892	66	.02251	3.07	.04572	.0006927
43501	25.0	1.4464	93	.01555	4.13	.05974	.0006423
48701	28.6	5.2800	321	.01643	3.06	.16124	.0005038
48801	25.0	9.8346	547	.01798	2.70	.26553	.0004877
57801	20.0	4.8988	270	.01814	2.87	.14060	.0005207
57901	25.0	2.4731	221	.01118	3.18	.07859	.0003556
58801	28.6	12.5470	626	.02024	2.31	.33541	.0004658
71901	20.0	28.2136	1,260	.02239	2.47	.69688	.0005531
80301	20.0	15.7835	729	.02165	1.81	.28569	.0003919
81501	20.0	2.8327	146	.01940	2.94	.08328	.0005704
91901	22.2	3.4961	199	.01756	3.09	.10771	.0005415
94601	28.6	6.2877	106	.04425	1.87	.11373	.0008062
Average	23.5	6.84457	341.75	.019779	2.88	.18065	.0005527

30 TO 40 PER CENT.

26101	33.3	1.9790	122	0.01704	3.19	0.06318	0.0005091
28201	33.3	4.3698	219	.01996	3.07	.13415	.0006126
28801	33.3	8.3240	386	.02311	2.96	.25019	.0006842
33901	33.3	6.7169	313	.02057	2.21	.12186	.0004466
37901	33.3	.5757	28	.01820	2.48	.01447	.0004556
38501	37.5	5.03306	252	.01814	3.25	.24284	.0006738
38701	33.3	7.2545	365	.01988	2.59	.18789	.0005148
48301	33.3	7.3424	315	.02117	3.08	.21633	.0006433
50901	33.3	2.0631	167	.01000	3.43	.07041	.0004496
59601	33.3	8.4456	474	.01796	2.14	.18099	.0003842
69701	33.3	3.7810	244	.01550	2.50	.09453	.0003874
88901	33.3	7.6051	419	.01812	2.74	.20632	.0004966
92301	33.3	4.1975	253	.01611	3.93	.18308	.0006454
Average	33.6	5.2065	273.6	.01813	2.89	.15125	.0005310

40 TO 50 PER CENT.

17501	42.9	1.1495	55	0.01865	4.01	0.04268	0.0007259
21301	44.4	4.6950	259	.01819	3.01	.14144	.0005449
33101	42.9	2.9905	156	.01858	2.73	.07566	.0005066
44601	42.9	1.8251	93	.01963	2.73	.04998	.0005390
50701	40.0	.5329	32	.01664	3.17	.01712	.0005396
72401	40.0	8.3672	321	.02946	3.15	.26913	.0009502
72801	40.0	2.0970	110	.01906	3.01	.06312	.0005738
72901	40.0	2.6462	167	.01585	2.48	.06563	.0003930
76201	40.0	6.9409	472	.01456	3.40	.22024	.0004700
81401	40.0	2.9064	156	.01791	2.96	.07905	.0005288
86101	40.0	5.3261	314	.01622	2.59	.14008	.0004261
92201	44.4	4.1705	238	.01894	2.67	.11199	.0005053
92501	42.9	5.4034	297	.01771	3.32	.16649	.0005828
94401	42.9	8.6610	484	.01769	2.27	.20040	.0004046
Average	41.7	4.1223	225.3	.01843	2.96	.11736	.0005493

TABLE 29.—*Yields of plants, arranged according to percentage killed in each family*—Cont'd.

50 TO 60 PER CENT.

Record number for 1902.	Percentage of plants in 1903 surviving from 1902.	Weight of kernels on plant (gram).	Number of kernels.	Weight of average kernel (gram).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in kernels (gram).	Proteid nitrogen in average kernel (gram).
17301	50.0	3.0000	156	0.01980	3.21	0.09556	0.0006380
17401	54.5	11.7777	581	.01961	2.65	.30061	.0005161
20701	50.0	6.6626	327	.02012	2.85	.18906	.0005697
27201	50.0	12.9727	611	.02105	2.56	.31509	.0005371
33401	50.0	5.2333	271	.01818	1.98	.10621	0003569
33601	50.0	6.0463	273	.02205	2.61	.14759	.0005729
34201	57.1	6.8220	328	.02019	2.86	.18949	.0005769
37701	50.0	4.1993	237	.01946	2.64	.12164	.0005130
39501	50.0	1.9040	89	.02284	2.97	.05663	.0006768
45601	50.0	2.3719	140	.01497	2.36	.04852	.0003388
46101	50.0	4.8728	273	.01832	2.69	.13084	.0004924
55201	50.0	6.0242	309	.01844	2.83	.15608	.0005186
57601	57.1	9.3804	435	.02178	2.37	.18680	.0005150
63101	50.0	4.7193	224	.01984	2.82	.12281	.0005523
69801	50.0	7.2278	334	.02186	3.74	.17078	.0008247
85201	50.0	4.2040	295	.01468	2.63	.11078	.0003778
88601	57.1	5.6295	266	.02236	2.57	.14178	.0005366
Average	51.5	6.0616	302.9	.01974	2.73	.15237	.0005361

60 TO 70 PER CENT.

Record number for 1902.	Percentage of plants in 1903 surviving from 1902.	Weight of kernels on plant (gram).	Number of kernels.	Weight of average kernel (gram).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in kernels (gram).	Proteid nitrogen in average kernel (gram).
21201	66.7	2.5064	137	0.01956	3.57	0.09431	0.0006846
32201	60.0	5.8304	288	.01937	2.64	.11603	.0005027
32601	66.7	2.9653	166	.01890	2.62	.05309	.0006177
48101	66.7	11.6655	608	.01919	2.38	.27765	.0004567
48501	66.7	6.0446	341	.01813	3.06	.18124	.0005437
55001	66.7	8.6833	476	.01824	3.25	.25347	.0005928
55301	66.7	5.4606	280	.01874	2.27	.12536	.0004328
55501	66.7	10.4714	529	.01914	2.85	.29155	.0005428
57001	60.0	5.0125	319	.01725	2.71	.13688	.0004658
57301	66.7	7.7761	443	.01752	2.54	.20018	.0004588
57401	66.7	7.6312	383	.01973	2.49	.19910	.0004900
57501	66.7	8.1116	382	.02099	2.60	.20327	.0005320
63501	60.0	4.1723	229	.01791	2.17	.06748	.0003749
66001	66.7	5.9586	309	.01919	3.25	.17590	.0005924
72601	60.0	4.6412	265	.01758	4.04	.14328	.0007214
72701	66.7	9.3629	396	.02245	2.94	.28276	.0006629
73301	66.7	7.7977	354	.02194	2.59	.21334	.0005639
74601	60.0	8.3679	451	.01854	2.49	.20681	.0004589
84901	66.7	4.1284	209	.01951	2.87	.13763	.0005622
92901	62.5	4.6848	258	.01763	2.81	.12877	.0004908
95701	60.0	5.4211	318	.01672	2.58	.14079	.0004336
Average	64.6	6.5092	340	.01896	2.80	.17280	.0005324

70 PER CENT AND OVER.

Record number for 1902.	Percentage of plants in 1903 surviving from 1902.	Weight of kernels on plant (gram).	Number of kernels.	Weight of average kernel (gram).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in kernels (gram).	Proteid nitrogen in average kernel (gram).
21701	87.5	9.75524	447	0.02157	2.78	0.30200	0.0006049
21801	80.0	11.5721	622	.01963	3.13	.35575	.0006057
21901	88.9	8.3406	398	.02114	3.53	.30995	.0007501
22201	87.5	4.0677	229	.01674	3.16	.12604	.0005292
26801	80.0	7.1981	329	.02045	2.82	.20306	.0005768
26901	71.4	3.8910	206	.01871	2.77	.10870	.0005189
27301	80.0	6.6162	343	.01913	2.93	.18438	.0005447
27501	71.4	6.8618	310	.02152	2.69	.17267	.0005758
38601	71.4	3.9532	186	.01983	3.72	.11558	.0007264
48401	83.3	4.4668	277	.01502	2.90	.10033	.0004159
55601	83.3	10.2785	435	.02211	2.55	.29008	.0005589
55901	83.3	10.9242	489	.02234	2.56	.27788	.0005632
56101	75.0	10.7383	617	.01744	2.75	.29783	.0004790
56201	83.3	11.2241	563	.02034	2.49	.27997	.0005065
58201	75.0	2.8084	227	.01159	2.88	.08385	0003383
65301	83.3	7.5858	394	.02001	2.92	.18248	.0006050
74501	100.0	3.4799	191	.01695	2.78	.10355	.0004745
81701	100.0	12.7593	569	.02272	2.27	.29500	.0005170
92401	71.4	4.4131	234	.01822	2.63	.12426	.0004826
94201	83.3	5.9603	339	.01748	2.58	.16548	.0004426
94901	75.0	7.0172	388	.01780	2.85	.21294	.0005072
95501	100.0	7.2956	374	.01767	2.50	.18689	.0004418
Average	82.4	7.3275	371.2	.01902	2.83	.20357	.0005348

TABLE 30.—*Summary of yields of plants, arranged according to percentage killed in each family.*

Percentage of plants grouped according to survivors of 1903 from 1902.	Number of analyses.	Percentage of plants in 1903 surviving from 1902.	Weight of kernels on plant (grams).	Number of kernels per plant.	Weight of average kernel (gram).	Percentage of proteid nitrogen in kernels.	Proteid nitrogen (gram) in—	
							Kernels.	Average kernel.
10 to 20	30	15.8	4.7098	251	0.01856	2.91	0.12294	0.0005437
20 to 30	20	23.5	6.8446	342	.01978	2.88	.18065	.0005527
30 to 40	13	33.6	5.2065	274	.01813	2.89	.15125	.0005310
40 to 50	14	41.7	4.1223	225	.01843	2.96	.11736	.0005493
50 to 60	17	51.5	6.0616	303	.01974	2.73	.15237	.0005361
60 to 70	21	64.6	6.5092	340	.01896	2.80	.17280	.0005324
70 and over	22	82.4	7.3275	371	.01902	2.83	.20357	.0005348

YIELD AND NITROGEN CONTENT OF GRAIN AS AFFECTED BY LENGTH OF GROWING PERIOD.

Early-maturing varieties of wheat are, in general, better yielding sorts in Nebraska than are later maturing ones. There are some exceptions to this rule, however, Turkish Red yielding better than any earlier maturing variety. The advantages from early maturity have usually been ascribed to the cooler weather and greater supply of moisture that obtain in the early summer. The hot, dry weather common in July is thought to prevent the filling out of the kernel and to cause light yield and light volume weight.

Each wheat plant on the breeding plots was harvested separately in 1903, and a record was kept of the date of harvesting of each of these plants. These data have been tabulated for the purpose of showing the relation between the length of the growing season and the yield of grain from individual plants of the same variety.

Table 31 contains these data, tabulated according to the date of ripening. Plants ripening between the 7th and 11th of July, 1903, form the first class, those ripening between July 11 and 15 the second class, and the succeeding classes increase by four days until July 27, all ripening after that date constituting the last class. The dates of ripening thus extend over a period of three weeks.

The season of 1903 was a very wet and cool one. The effect of this upon the wheat crop is shown by the fact that the crop in the field was not ready to harvest until July 10, while usually it is harvested between the 20th and 30th of June. Even at the close of the ripening period the weather did not become dry or hot as compared with the normal season. It will therefore be seen that the ordinary advantages from early maturity did not obtain, or at least not in the customary way. It may also be said that some of the later maturing wheats yielded as well in 1904 as did the Turkish Red.

Table 32 is a summary of Table 31, with a statement of the average for each class.

Table 33 is a summary of the same plants, tabulated according to the yield of grain per plant.

Table 34 is a summary of the same plants, tabulated according to the percentage of proteid nitrogen.

It is very evident from these tables that the early-maturing plants are the most prolific. The weight of the average kernel remains very uniform, so that the later maturing plants do not appear to have produced shrunken kernels. Evidently the plants ripening during the first four days produced the largest amounts of grain, and their kernels were as heavy as those produced later. The smaller productiveness of the later maturing plants in the season of 1903 does not appear to have been due to a shrunken or light kernel.

The percentage of proteid nitrogen appears to be somewhat less in the grain of the early-maturing plants. The number of grams of proteid nitrogen in the average kernel is likewise less in these early-maturing plants.

The relation of length of growing season to both yield and composition of grain is contrary to what might have been supposed. A long growing period without excessively hot or dry weather might naturally be thought to increase the yield and increase the percentage of carbohydrates in the grain.

The season of 1904 was very similar to that of 1903 up to time of wheat harvest. The data for 1904, when tabulated, will serve as a check on the results obtained in 1903.

TABLE 31.—*Yield and nitrogen content of grain, tabulated according to length of growing period.*

DATES RIPE: JULY 7 TO 11, 1903.

Record number.	Date ripe.	Yield (grams).	Percentage of proteid nitrogen.	Weight of average kernel (gram).	Proteid nitrogen (gram) in—	
					Kernels.	Average kernel.
21805	July 10	20.9290	2.69	0.01699	0.56299	0.0004569
21806	...do...	14.2450	2.71	.02378	.38604	.0006444
21807	...do...	9.4172	2.73	.02498	.25709	.0006664
21808	...do...	19.7446	2.57	.01708	.50744	.0004389
21809	...do...	8.0214	2.73	.01919	.21898	.0005238
21810	...do...	1.0304	2.69	.019816	.02772	.0005330
21811	...do...	11.9114	3.75	.021007	.44666	.0007877
21812	...do...	14.8139	4.26	.01507	.63107	.0006420
21813	...do...	4.0258	4.04	.01877	.16377	.0007582
55506	July 8	17.8506	2.80	.02062	.49995	.0005773
55507	...do...	9.8228	2.63	.01949	.25834	.0005126
55605	...do...	10.9180	2.64	.02184	.28823	.0005765
55606	...do...	11.0930	2.58	.02205	.28580	.0005690
55607	...do...	2.3931	2.69	.01734	.06437	.0004665
55608	...do...	22.5848	2.31	.02699	.52194	.0006236
55905	...do...	5.7948	2.67	.01751	.15470	.0004674
55906	July 7	7.9968	2.81	.01603	.22471	.0004503
55907	July 8	19.3966	2.59	.02590	.50238	.0006707
55908	...do...	12.1221	2.42	.02175	.29575	.0005262
55909	July 9	9.2120	2.30	.03050	.21187	.0007016
56106	July 8	12.0161	2.57	.01866	.30881	.0004795
56107	July 7	14.4556	2.96	.01658	.42790	.0004907
56206	July 8	9.3093	2.42	.01829	.22529	.0004426
56207	...do...	10.9073	2.34	.02361	.25522	.0005524
56208	...do...	13.5720	2.61	.02356	.34616	.0006149
56209	...do...	15.8086	2.59	.01664	.40945	.0004310
81505	July 10	2.8327	2.94	.01940	.08328	.0005704
81706	July 8	15.3928	2.71	.02132	.41715	.0005778
81707	...do...	18.3614	2.34	.02336	.42965	.0005466
81708	...do...	7.3993	2.41	.02578	.17833	.0006213
81709	...do...	16.4692	2.28	.02175	.37548	.0004960

TABLE 31.—*Yield and nitrogen content of grain, tabulated according to length of growing period*—Continued.

DATES RIPE: JULY 7 TO 11, 1903—Continued.

Record number.	Date ripe.	Yield (grams).	Percentage of proteid nitrogen.	Weight of average kernel (gram).	Proteid nitrogen (gram) in—	
					Kernels.	Average kernel.
81710	July 8	9.1411	1.92	0.02308	0.17550	0.0004432
88605	July 10	1.6362	2.80	.02731	.04581	.0007640
88606	....do...	9.9456	2.53	.02068	.25162	.0005231
88607	....do...	5.1584	2.61	.02205	.13463	.0005754
88608	....do...	1.5355	2.47	.02075	.03793	.0005125
88609	....do...	9.8719	2.42	.02100	.23890	.0005082
94907	....do...	12.1918	2.94	.01948	.35844	.0005726
94908	....do...	2.3678	1.96	.01894	.04641	.0003713
94909	July 9	3.6977	3.60	.01696	.13312	.0006106
95505	....do...	.3146	2.81	.00850	.00884	.0002389
95506	....do...	11.0548	2.74	.01852	.30291	.0005074
95507	....do...	12.1592	2.59	.02029	.31492	.0005515
95508	....do...	14.4617	2.56	.01954	.37023	.0005003
95509	....do...	2.9475	2.48	.02136	.07310	.0005297
95510	....do...	2.8356	1.81	.01783	.05132	.0003228
95705	July 10	10.3426	2.54	.01626	.26270	.0004131
95706	....do...	5.1629	2.73	.01934	.14095	.0005279
95707	....do...	.7577	2.47	.01457	.01872	.0003599
Average	July 8.9	9.9067	2.69	.02024	.26475	.0005356

DATES RIPE: JULY 11 TO 15, 1903.

21905	July 13	14.3111	2.64	0.01809	0.37781	0.0004777
21906	....do...	10.4800	3.18	.02563	.33403	.0008168
21907	....do...	2.9248	3.35	.01851	.09798	.0006201
21908	....do...	3.5574	3.82	.02056	.13589	.0007855
21909	....do...	12.1819	4.43	.02317	.53889	.0010265
21911	....do...	8.4593	5.48	.02209	.46356	.0012103
21912	....do...	9.7236	2.31	.01907	.22461	.0004404
21913	....do...	10.1925	3.01	.02072	.30680	.0006235
22205	....do...	2.6965	2.81	.00953	.07577	.0002677
22210	....do...	6.0173	3.17	.02019	.19075	.0006401
22211	....do...	11.5675	3.17	.02062	.36671	.0006537
27005	....do...	16.4120	2.63	.01895	.43164	.0004984
27205	....do...	16.4061	2.41	.01841	.39539	.0004437
27206	....do...	19.1854	2.36	.02469	.45276	.0005827
27207	....do...	3.3266	2.92	.02004	.09712	.0005850
27305	....do...	5.5666	2.58	.02085	.14362	.0005379
27306	....do...	13.3011	3.47	.01945	.32853	.0004803
27307	....do...	3.0850	2.53	.01847	.07805	.0004674
27308	....do...	4.5123	4.15	.01777	.18726	.0007373
27505	....do...	12.0399	2.12	.02183	.24942	.0004627
27506	....do...	10.0005	2.70	.02252	.27003	.0006082
27508	....do...	5.5324	2.64	.02287	.14608	.0006037
48406	....do...	3.2964	4.87	.01324	.16053	.0006447
48407	....do...	11.2890	1.50	.01572	.16933	.0002358
48408	....do...	.3485	2.81	.01291	.00979	.0003627
48409	....do...	6.4302	2.02	.02048	.12989	.0004137
48506	....do...	9.4585	3.20	.01701	.30267	.0005444
48507	....do...	1.6036	2.64	.02296	.04233	.0006062
48508	....do...	11.2008	2.76	.01858	.30986	.0005127
48806	....do...	9.8346	2.70	.01798	.26553	.0004877
55005	....do...	7.9684	3.05	.02028	.24303	.0006185
55006	....do...	7.1852	3.16	.01593	.22705	.0005034
55305	....do...	2.5160	2.48	.01507	.06240	.0003736
55306	....do...	4.1323	2.18	.01931	.09008	.0004210
55307	....do...	5.6864	1.89	.01663	.10747	.0003142
55308	....do...	9.5078	2.54	.02395	.24150	.0006225
56105	....do...	5.7431	2.73	.01709	.15679	.0004667
56205	....do...	6.5232	2.51	.01959	.16373	.0004917
57005	....do...	1.5364	2.71	.01746	.04164	.0004731
57006	....do...	10.1836	2.76	.01453	.28107	.0004010
57007	....do...	3.3176	2.65	.01975	.08792	.0005233
57105	....do...	3.7263	2.76	.00916	.10285	.0002527
57305	....do...	8.5777	3.19	.01666	.29188	.0005826
57306	....do...	7.9772	2.86	.01838	.22815	.0005257
57307	....do...	4.7117	2.43	.01801	.11445	.0004387
57308	....do...	9.8378	1.69	.01705	.16626	.0002881
57405	....do...	.8328	1.98	.02031	.01649	.0004022
57406	....do...	2.4923	2.75	.01846	.06854	.0005077
57407	....do...	14.9992	2.62	.01968	.39297	.0005157

TABLE 31.—*Yield and nitrogen content of grain, tabulated according to length of growing period*—Continued.

DATES RIPE: JULY 11 TO 15, 1903—Continued.

Record number.	Date ripe.	Yield (grams).	Percentage of proteid nitrogen.	Weight of average kernel (gram).	Proteid nitrogen (gram) in—	
					Kernels.	Average kernel.
57408	July 13	12.2004	2.61	0.02047	0.31842	0.0005343
57506	....do...	2.7616	2.80	.01534	.07733	.0004296
57507	....do...	6.9861	2.85	.01946	.19905	.0005545
57508	....do...	12.0728	2.21	.03177	.26680	.0007021
57509	....do...	10.6261	2.54	.01739	.26990	.0004417
57606	....do...	3.0790	2.74	.02333	.08436	.0006391
57607	....do...	16.4433	1.73	.02234	.24847	.0003865
57608	....do...	8.6189	2.64	.01968	.22756	.0005195
58206	....do...	1.3961	2.67	.00943	.03728	.0002519
58207	....do...	4.2207	3.09	.01375	.13042	.0004248
65305	....do...	1.8018	4.92	.02310	.08865	.0011365
65306	....do...	9.8298	2.41	.01807	.23690	.0004355
65307	....do...	7.0051	2.28	.01878	.15971	.0004282
65308	....do...	11.7006	2.09	.02008	.24468	.0004197
94905	July 11	4.4423	2.35	.01553	.10439	.0003650
94906	....do...	12.3862	3.41	.01808	.42236	.0006166
Average..	July 13	7.6611	2.81	.01887	.20820	.0005290

DATES RIPE: JULY 15 TO 19, 1903.

Record number.	Date ripe.	Yield (grams).	Percentage of proteid nitrogen.	Weight of average kernel (gram).	Proteid nitrogen (gram) in kernels.	Proteid nitrogen (gram) in average kernel.
18906	July 15	0.9229	3.48	0.01420	0.03212	0.0004941
21706	....do...	19.3318	4.71	.02390	.91052	.0011283
21707	....do...	12.3685	2.19	.02125	.27086	.0004654
26105	....do...	1.8242	3.02	.01393	.05508	.0003662
33406	July 18	4.6045	2.87	.01627	.13215	.0004670
34206	....do...	1.5940	3.73	.01968	.05946	.0007340
34208	....do...	2.9886	2.13	.01916	.06366	.0004081
37906	July 15	.2062	2.44	.01086	.00503	.0002649
45005	....do...	3.2340	3.58	.01376	.11575	.0004927
45605	....do...	.7081	2.82	.01161	.01997	.0003273
48405	....do...	.9701	3.31	.01276	.03211	.0004225
48505	....do...	1.9154	3.66	.01398	.07010	.0005117
51005	....do...	15.5835	1.34	.01804	.20881	.0002422
63105	July 18	1.5452	3.24	.01717	.05007	.0005563
63106	....do...	3.3006	2.79	.02001	.09208	.0005581
66006	....do...	6.0090	3.54	.01642	.21272	.0005812
72605	....do...	1.1166	4.65	.01718	.05192	.0007988
72806	....do...	2.0970	3.01	.01906	.06312	.0005738
74605	....do...	7.1181	2.60	.01784	.18507	.0004638
81705	....do...	9.7922	1.98	.02106	.19388	.0004170
88905	July 16	5.3069	2.83	.01811	.15019	.0005126
88906	....do...	9.9034	2.65	.01814	.26245	.0004807
91905	....do...	3.4436	3.36	.01739	.11570	.0005844
91906	....do...	3.5486	2.81	.01774	.09972	.0004986
92205	....do...	5.2616	2.74	.01525	.14417	.0004179
92206	....do...	1.1074	2.67	.02407	.02957	.0006428
92207	....do...	3.6926	2.55	.01767	.09416	.0004505
92208	....do...	6.6206	2.72	.01876	.18008	.0005102
92305	....do...	2.3859	2.93	.01491	.06991	.0004369
92306	....do...	6.0091	4.93	.01732	.29625	.0008539
92406	....do...	8.2366	3.11	.02168	.25616	.0006741
92407	....do...	.8983	1.66	.01695	.01491	.0002814
92408	....do...	3.7820	2.97	.01827	.11233	.0005426
92409	....do...	5.7131	2.30	.01814	.13140	.0004171
92506	....do...	3.8709	4.39	.01690	.16993	.0007421
92507	....do...	9.6779	2.58	.01916	.24969	.0004944
92905	....do...	2.7000	3.50	.01534	.09450	.0005369
92906	....do...	2.8816	2.99	.01592	.08616	.0004760
92907	....do...	4.4673	2.56	.02040	.11436	.0005220
92908	....do...	3.2388	2.32	.01732	.07514	.0004018
92909	....do...	10.1363	2.70	.01916	.27367	.0005173
94105	July 15	.5595	2.67	.02543	.01494	.0006790
94205	July 16	1.2117	1.65	.01893	.01999	.0003124
94206	....do...	7.5006	2.78	.01866	.20851	.0005187
94207	....do...	13.7057	2.86	.01909	.39199	.0005460
94208	....do...	3.7828	3.10	.01175	.11727	.0003642
94406	....do...	10.5556	2.47	.01923	.26073	.0004749
94407	....do...	6.7664	2.07	.01615	.14007	.0003343
94605	....do...	.7319	1.95	.01307	.01427	.0002549
94606	....do...	11.8435	1.80	.07544	.21319	.0013576
Average..	July 16.2	5.1354	2.87	.01869	.14452	.0005222

TABLE 31.—*Yield and nitrogen content of grain, tabulated according to length of growing period*—Continued.

DATES RIPE: JULY 19 TO 23, 1903.

Record number.	Date ripe.	Yield (grams).	Percentage of proteid nitrogen.	Weight of average kernel (gram).	Proteid nitrogen (gram) in— Kernels.	Proteid nitrogen (gram) in— Average kernel.
17409	July 21	14.8957	2.75	0.01857	0.40964	0.0005108
17505	July 20	.3885	4.70	.01340	.01826	.0006296
18805	July 21	2.1462	2.02	.01567	.04335	.0003164
20707	....do...	9.9070	2.77	.02282	.27443	.0006181
20708	July 20	2.4690	2.58	.02024	.06399	.0005221
21211	July 21	.2806	3.15	.02806	.00884	.0008839
21306	July 20	4.1516	2.90	.01837	.12039	.0005327
21308	....do...	5.8080	3.45	.01641	.20038	.0005660
21710	July 21	.8478	2.59	.01437	.02196	.0003722
21711	....do...	17.1820	2.71	.01968	.46563	.0005334
22209	....do...	.4336	3.84	.01399	.01665	.0005371
26806	July 20	2.7255	2.60	.01793	.07086	.0004662
26807	....do...	17.2324	2.80	.02390	.48250	.0006692
26808	....do...	3.8811	3.09	.01748	.11992	.0005402
26906	July 22	4.2376	2.71	.01859	.11484	.0005037
26907	July 20	1.8276	2.61	.01792	.04995	.0004677
26909	....do...	2.9999	2.80	.01667	.08400	.0004667
32606	July 22	2.0162	2.88	.02145	.05807	.0006177
33105	July 21	2.5601	2.91	.01939	.07450	.0005644
33905	....do...	11.1476	1.61	.02194	.17948	.0003533
33906	....do...	2.2862	2.81	.01921	.06424	.0005399
38606	....do...	8.4605	2.63	.02110	.22251	.0005549
38607	....do...	.3037	4.55	.01598	.01382	.0007273
38608	....do...	3.0228	2.82	.01913	.08522	.0005394
38609	....do...	6.7665	2.74	.02319	.18540	.0006475
38706	July 20	7.2545	2.59	.01988	.18789	.0005148
40405	July 21	.6316	3.17	.01373	.02002	.0004352
42206	....do...	.3161	1.46	.01264	.00462	.0001846
44607	July 20	1.8246	2.44	.01806	.04452	.0004408
48106	July 21	11.6655	2.38	.01919	.27765	.0004567
48305	July 20	12.0278	2.87	.02543	.34524	.0007299
48306	....do...	2.6571	3.29	.01692	.08742	.0005568
48706	....do...	6.1989	3.00	.01635	.18596	.0004906
55007	....do...	2.1571	4.21	.01828	.09082	.0007696
55008	July 21	17.4226	2.60	.01846	.45299	.0004799
55206	....do...	11.3592	2.56	.01965	.29079	.0005031
58805	July 20	23.1471	2.74	.01999	.63422	.0005464
59606	....do...	9.7084	2.16	.01712	.20970	.0003698
63107	....do...	9.3120	2.43	.02233	.22628	.0005426
63505	July 21	4.0230	1.90	.01934	.07644	.0003674
66008	July 20	3.1555	3.59	.01814	.11328	.0006510
69305	....do...	2.0430	4.42	.01984	.09030	.0008767
71905	....do...	28.2136	2.47	.02239	.69688	.0005531
72606	....do...	9.3629	1.89	.01724	.18538	.0003414
72607	....do...	3.4442	5.59	.01832	.19253	.0010241
72705	....do...	9.1522	2.13	.02191	.19936	.0004668
72706	....do...	14.6802	3.86	.02484	.56666	.0009588
72707	July 21	4.5806	3.49	.02036	.15986	.0007105
72708	July 20	9.0386	2.27	.02270	.20518	.0005154
74507	July 21	9.2130	3.02	.01869	.27823	.0005644
76206	July 20	5.4411	4.45	.01217	.24213	.0005417
84905	....do...	.7130	2.32	.01927	.01654	.0004471
84906	....do...	7.5438	3.43	.01975	.25873	.0006773
85206	July 21	4.9315	2.66	.01312	.13118	.0003332
92405	....do...	3.4356	3.10	.01605	.10650	.0004977
94209	....do...	3.6006	2.49	.01895	.08965	.0004719
Average	July 20.1	6.5399	2.93	.01886	.18064	.0005482

DATES RIPE: JULY 23 TO 27, 1903.

17305	July 23	3.6302	3.03	0.01984	0.10999	0.0006010
17306	....do...	3.9968	3.09	.01645	.12350	.0005082
17308	....do...	1.2275	3.25	.02012	.03994	.0006540
17406	....do...	2.0907	3.29	.01686	.06878	.0005547
17408	....do...	9.2038	2.18	.01852	.20065	.0004037
17410	....do...	16.9987	2.88	.02285	.48957	.0006580
20705	....do...	1.8517	3.09	.01698	.05722	.0005249
20706	....do...	3.3138	2.78	.02033	.09212	.0005652
20710	....do...	17.1115	2.83	.01974	.48428	.0005586
20805	....do...	14.6942	3.32	.02157	.48784	.0006999

TABLE 31.—*Yield and nitrogen content of grain, tabulated according to length of growing period*—Continued.

DATES RIPE: JULY 23 TO 27, 1903—Continued.

Record number.	Date ripe.	Yield (grams).	Percentage of protein nitrogen.	Weight of average kernel (gram).	Protein nitrogen (gram) in—	
					Kernels.	Average kernel.
21307	July 24	2.5691	3.04	0.01796	0.07810	0.0005461
21705	July 23	1.5420	2.45	.02659	.03778	.0006514
21708	....do...	9.2850	2.33	.02381	.21634	.0005547
21709	....do...	7.7296	2.47	.02141	.19092	.0005289
22206	....do...	2.5712	3.22	.01720	.08086	.0005538
22208	....do...	1.9090	3.18	.01619	.06071	.0005144
26905	July 24	6.4102	2.76	.01966	.17692	.0005427
26908	....do...	3.9797	2.96	.02073	.11780	.0006135
27507	July 23	1.3746	3.08	.01833	.04234	.0005646
27509	....do...	5.3615	2.90	.02206	.15549	.0006399
28805	....do...	2.1851	2.91	.02512	.04359	.0007309
28806	....do...	14.4630	3.02	.02111	.43679	.0006376
33106	....do...	.3089	2.94	.01716	.00908	.0005045
33107	....do...	6.1026	2.35	.01919	.14341	.0004510
33405	....do...	8.1268	2.03	.01930	.16498	.0003919
34205	....do...	9.1498	2.73	.01972	.24979	.0005383
34207	....do...	13.5556	2.84	.02219	.38505	.0006273
38506	July 24	1.6799	2.89	.01975	.04855	.0005712
38605	July 23	1.2124	5.85	.01987	.07093	.0011627
40205	....do...	3.6302	4.69	.01871	.17026	.0008776
40305	....do...	3.6003	3.11	.02011	.11197	.0006255
42905	....do...	1.2499	3.17	.01866	.03650	.0005447
44505	....do...	5.9990	2.94	.01764	.17637	.0005187
44606	....do...	2.5235	2.90	.02035	.07318	.0005902
45606	....do...	4.0358	1.91	.01834	.07708	.0003504
45705	....do...	.7532	4.18	.01712	.03148	.0007155
45805	....do...	1.5298	1.84	.01234	.02815	.0002700
46107	....do...	8.3935	2.54	.01756	.21319	.0004460
50705	....do...	.5958	3.54	.01986	.02109	.0007032
50706	....do...	.4701	2.80	.01343	.01316	.0003761
50905	....do...	2.3982	3.30	.01085	.07914	.0003581
55205	July 24	.6893	3.10	.01723	.02137	.0005342
57805	....do...	4.8988	2.87	.01814	.14060	.0005207
57905	....do...	2.4731	3.18	.01118	.07859	.0003556
58505	July 23	7.4516	2.95	.02730	.21982	.0008052
58705	....do...	2.5436	3.01	.01082	.07656	.0003258
60605	....do...	.5952	1.87	.01701	.01113	.0003180
62805	....do...	1.3451	3.25	.01212	.04272	.0003938
74606	....do...	9.6451	2.30	.02079	.22184	.0004781
74607	....do...	8.3406	2.56	.01699	.21352	.0004349
91305	July 24	3.0940	3.21	.02242	.09932	.0007197
92505	....do...	2.6615	3.00	.01706	.07985	.0005118
Average..	July 23.2	4.9015	2.93	.01878	.13654	.0005544

DATES RIPE: JULY 27, 1903, OR LATER.

17307	July 27	3.1454	3.46	0.02279	0.10883	0.0007886
17405	....do...	15.6996	2.13	.02127	.33441	.0004531
17506	....do...	2.2881	3.52	.02460	.08044	.0008660
17507	....do...	.7720	3.80	.01795	.02934	.0006822
18905	....do...	1.4864	3.81	.01443	.05663	.0005498
20709	....do...	5.3229	3.05	.02063	.16235	.0006292
21205	....do...	2.3642	3.16	.01922	.07471	.0006074
21206	....do...	2.8564	5.23	.01917	.14939	.0010026
21207	....do...	2.3066	2.96	.01955	.06804	.0005766
21208	....do...	5.1594	3.24	.01798	.16712	.0005824
21209	....do...	1.4484	3.61	.01627	.05228	.0005875
21210	....do...	3.9143	5.03	.01577	.19689	.0007934
21212	....do...	1.7216	2.16	.02049	.03718	.0004427
21305	....do...	6.2514	2.67	.020037	.16691	.0005350
22207	....do...	3.2787	2.77	.01940	.09082	.0005374
25205	....do...	10.7836	2.71	.02066	.28560	.0005599
25206	....do...	4.6754	2.76	.02281	.12904	.0006295
26106	....do...	2.0737	2.63	.02304	.05454	.0006060
26107	....do...	2.0390	3.92	.01416	.07993	.0005551
26805	....do...	4.9456	2.81	.02248	.13897	.0006317
28206	....do...	4.3698	3.07	.01996	.13415	.0006126
32206	....do...	10.4036	1.81	.02052	.18831	.0003714
32207	....do...	1.2573	3.48	.01822	.04375	.0006341
32605	....do...	5.2268	1.20	.02323	.06272	.0002788

TABLE 31.—*Yield and nitrogen content of grain, tabulated according to length of growing period*—Continued.

DATES RIPE: JULY 27, 1903, OR LATER—Continued.

Record number.	Date ripe.	Yield (grams).	Percentage of proteid nitrogen.	Weight of average kernel (gram).	Proteid nitrogen (gram) in—	
					Kernels.	Average kernel.
32608	July 27	1.0183	3.78	0.01851	0.03849	0.0006998
33305	....do...	3.1346	3.41	.02090	.10689	.0007126
33407	....do...	7.0889	1.62	.02271	.11223	.0003679
33408	....do...	1.1132	1.39	.01446	.01547	.0002009
33605	....do...	7.0596	2.39	.02345	.16872	.0005605
33606	....do...	8.1890	2.21	.02144	.18098	.0004738
33607	....do...	2.8903	3.22	.02125	.09307	.0006843
34405	....do...	4.1281	4.33	.01994	.17875	.0008635
34606	....do...	6.1962	3.12	.02213	.19332	.0006904
36905	....do...	5.0200	3.88	.01880	.19478	.0007295
37305	....do...	6.1394	2.96	.01987	.18173	.0005881
37705	....do...	8.0905	2.64	.01972	.23998	.0005327
37706	....do...	1.2069	2.34	.02155	.02824	.0005053
37707	....do...	3.3004	2.93	.01710	.09670	.0005010
37905	Aug. 4	.9452	2.53	.02555	.02391	.0006433
38005	July 27	2.5134	2.84	.01808	.07138	.0005135
38505	....do...	12.1088	3.61	.02252	.43713	.0007764
39205	....do...	21.5399	2.11	.02089	.45435	.0004407
39405	....do...	9.3541	2.88	.02093	.21399	.0006027
39506	Aug. 4	1.9218	2.93	.02869	.05631	.0008404
39507	July 27	1.8862	3.02	.01699	.05696	.0005132
39606	....do...	4.6383	2.37	.01341	.10967	.0003177
40505	....do...	4.1546	2.82	.02444	.11716	.0006892
42205	....do...	1.8494	3.63	.01967	.06713	.0007142
42405	....do...	1.4892	3.07	.02251	.04572	.0006927
43405	....do...	2.8000	2.92	.02258	.08176	.0006594
43505	Aug. 4	1.4464	4.13	.01555	.05974	.0006423
44605	July 27	1.1271	2.86	.02049	.03223	.0005861
46105	....do...	4.6146	3.00	.01775	.13843	.0005324
46106	....do...	1.6103	2.54	.01964	.04090	.0004988
48705	....do...	4.3615	3.13	.01652	.13652	.0005171
49505	....do...	1.2716	3.24	.01898	.04120	.0006149
49905	....do...	.6760	3.62	.02939	.02436	.0010640
50906	....do...	1.7280	3.57	.01516	.06169	.0005411
55508	....do...	3.7407	3.11	.01732	.11636	.0005386
58806	....do...	1.9469	1.88	.02049	.03660	.0003853
58905	....do...	2.3031	2.43	.01355	.05596	.0003292
59605	....do...	7.1828	2.12	.01880	.15228	.0003986
63506	....do...	2.3986	2.44	.01568	.05853	.0003825
66005	....do...	7.6690	2.63	.02073	.20170	.0005451
69506	....do...	13.5696	2.50	.02047	.33923	.0005117
69805	....do...	2.4420	5.82	.02220	.14213	.0012921
69806	....do...	12.0136	1.66	.02153	.19943	.0003574
72405	....do...	8.4415	3.36	.03963	.28363	.0013316
72406	....do...	8.2929	2.95	.01929	.24464	.0005689
72905	....do...	2.6462	2.48	.01585	.06563	.0003930
73307	....do...	.5572	2.39	.02229	.01332	.0005327
73308	....do...	14.2986	2.92	.02291	.41752	.0006539
74305	....do...	4.4222	1.98	.02047	.08756	.0004054
74506	....do...	.4096	2.73	.01781	.01118	.0004862
74508	....do...	.8172	2.60	.01434	.02125	.0003728
76205	....do...	8.4407	2.35	.01695	.19836	.0003982
80305	....do...	15.7835	1.81	.02165	.28569	.0003919
81405	....do...	4.5737	2.62	.01862	.11710	.0004879
81406	....do...	1.2391	3.31	.01721	.04101	.0005697
84405	....do...	8.7448	2.48	.02043	.21687	.0005067
85205	....do...	3.4766	2.60	.01625	.09039	.0004224
86105	....do...	3.0282	2.56	.01495	.07964	.0003923
86106	....do...	7.6241	2.63	.01749	.20052	.0004599
Average..	July 27.2	4.6636	2.94	.01992	.12854	.0005800

TABLE 32.—*Summary of yield and nitrogen content of grain, tabulated according to length of growing period.*

Plants grouped according to date ripe.	Number of analyses.	Average date ripe.	Yield (grams).	Percentage of proteid nitrogen.	Weight of average kernel (gram).	Proteid nitrogen (gram) in— Kernels.	Proteid nitrogen (gram) in— Average kernel.
July 7 to 11	49	July 8.9	9.9067	2.69	0.02024	0.26475	0.0005356
July 11 to 15	65	July 13	7.6611	2.81	.01887	.20820	.0005290
July 15 to 19	50	July 16.2	5.1354	2.87	.01869	.14452	.0005222
July 19 to 23	56	July 20.1	6.5399	2.93	.01886	.18064	.0005482
July 23 to 27	52	July 23.2	4.9015	2.93	.01878	.13654	.0005544
July 27, or later	83	July 27.2	4.6636	2.94	.01992	.12854	.0005800

TABLE 33.—*Summary of nitrogen content, etc., tabulated according to yield per plant.*

Plants grouped according to yield (in grams).	Number of analyses.	Average date ripe.	Yield (grams).	Percentage of proteid nitrogen.	Weight of average kernel (gram).	Proteid nitrogen (gram) in— Kernels.	Proteid nitrogen (gram) in— Average kernel.
Below 1	31	July 20.2	0.6049	2.91	0.01683	0.01731	0.0004916
1 to 2.5	67	July 21.9	1.7673	3.09	.01852	.05456	.0005730
2.5 to 5	88	July 20	3.5683	3.03	.01796	.10794	.0005445
5 to 10	94	July 18.3	7.6706	2.68	.01997	.20270	.0005351
10 to 15	52	July 15.1	12.2573	2.71	.02168	.33433	.0005774
15 to 20	20	July 15.1	17.1908	2.54	.02103	.43921	.0005382
More than 20	4	July 14.5	23.7186	2.55	.02159	.60401	.0005450

TABLE 34.—*Summary of yield, etc., tabulated according to nitrogen content.*

Plants grouped according to percentage of nitrogen.	Number of analyses.	Average date ripe.	Yield (grams).	Percentage of proteid nitrogen.	Weight of average kernel (gram).	Proteid nitrogen (gram) in— Kernels.	Proteid nitrogen (gram) in— Average kernel.
Below 1.5	4	July 22.5	5.8099	1.35	0.01709	0.07290	0.0002266
1.5 to 2	25	July 18.5	2.7423	1.80	.02124	.11620	.0003867
2 to 2.25	18	July 19.8	8.9542	2.12	.02030	.19070	.0004325
2.25 to 2.5	47	July 17.3	7.3389	2.39	.02000	.18478	.0004773
2.5 to 2.75	82	July 16.3	8.0817	2.63	.01938	.21280	.0005102
2.75 to 3	67	July 19.6	5.9093	2.85	.01910	.16609	.0005454
3 to 3.25	47	July 21.2	4.4497	3.11	.01824	.13847	.0005667
3.25 to 3.5	20	July 20.7	4.6756	3.37	.01870	.15189	.0006213
3.5 to 4	23	July 21.5	3.6486	3.68	.01852	.13513	.0006807
More than 4	25	July 19.5	4.5431	4.72	.01819	.21239	.0008639

RELATION OF SIZE OF HEAD TO YIELD, HEIGHT, AND TILLERING OF PLANT.

The size of the head has always been considered to be closely connected with the productiveness of wheat. The well-known work of Hallet in increasing the yielding qualities of wheat is perhaps the best example of wheat improvement by the selection of plants having large heads. Whether large heads or a large number of medium-sized heads on a plant are more desirable is still a question.

Table 35 gives the yields, etc., of between 300 and 400 plants, tabulated according to the number of kernels on the head. Table 36 is a summary of these, while Tables 37 and 38 consist of the same data tabulated according to the yield per plant and yield per head, respectively.

It will be seen from Table 36 that the heads of slightly more than medium size produced the largest yields of grain; that the weight of the average kernel did not increase with the size of the head, nor did it decrease except on the very largest heads; that the plants with somewhat more than average-sized heads were the tallest, and that the plants with medium-sized heads or slightly less tillered most largely.

Table 37 shows that with an increased yield per plant there is a constant increase in the height and tillering of the plant.

Table 38 indicates that the yield per head and yield per plant do not increase together, but that the largest yielding plants are those of medium yield per head. The same would seem to be true of the height and tillering of the plant. The weight of the average kernel increases quite uniformly with the yield per head.

In considering these results it must be borne in mind that these plants were grown 6 inches apart each way, and were therefore not under the conditions that would obtain in a thickly drilled or broadcasted field, where lack of ability to tiller would be compensated for by the larger number of plants. However, the variety of wheat yielding best in Nebraska is one having only a medium-sized or even small head, as compared with most wheats, but it is a strong-tillering variety.

TABLE 35.—*Relation of size of head to yield, height, and tillering of plant.*

SIZE OF HEAD, BELOW 16 KERNELS.

Record number.	Size of head.	Yield per plant (grams).	Yield per head (grams).	Weight of average kernel (grams).	Height (cm.).	Tillering.
17308	15.2	1.2275	0.3069	0.02012	59	5
17406	15.5	2.0907	.2613	.01686	65	11
18805	15.2	2.1462	.2385	.01567	65	18
20708	13.6	2.4690	.2743	.02024	60	11
21211	10.0	.2806	.2806	.02806	45	2
22209	15.5	.4336	.2168	.01399	70	6
26805	15.7	4.9456	.3533	.02248	68	26
32207	13.8	1.2573	.2515	.01822	47	5
37905	12.3	.9452	.3151	.02555	52	3
39506	11.2	1.9218	.3203	.02869	48	6
42206	12.5	.3161	.1580	.01264	63	5
44607	12.6	2.5235	.2281	.02035	52	12
48408	13.5	.3485	.1742	.01291	45	3
49905	11.5	.6760	.3380	.02939	49	2
50705	15.0	.5958	.2979	.01986	40	3
73307	12.5	.5572	.2786	.02229	46	4
74506	12.5	.4096	.2048	.01781	68	2
94105	11.0	.5595	.2797	.02543	51	1
Average	13.3	1.3169	.2654	.02059	55.2	6.9

SIZE OF HEAD, 16 TO 20 KERNELS.

17410	19.1	16.9987	0.4358	0.02285	84	46
21205	17.6	2.3642	.3378	.01922	55	10
21305	16.4	6.2514	.3290	.02004	65	21
21307	17.9	2.5691	.3211	.01796	53	10
21705	19.3	1.5420	.5140	.02659	73	3
21710	19.7	.8478	.2826	.01437	59	5

TABLE 35.—*Relation of size of head to yield, height, and tillering of plant*—Continued.

SIZE OF HEAD, 16 TO 20 KERNELS—Continued.

Record number.	Size of head.	Yield per plant (grams).	Yield per head (grams).	Weight of average kernel (grams).	Height (cm.).	Tillering.
21807	18.8	9.4172	0.4709	0.02498	77	25
22207	18.8	3.2787	.3643	.01940	65	16
22208	16.8	1.9090	.2727	.01619	57	8
26906	19.0	4.2376	.3531	.01859	70	16
26909	18.0	2.9999	.3000	.01667	50	10
28206	19.9	4.3698	.3972	.01996	80	26
33106	18.0	.3089	.3089	.01716	43	2
37706	18.7	1.2069	.4023	.02155	42	4
37906	19.0	.2063	.2063	.01086	50	2
38005	19.8	2.5134	.3591	.01808	53	7
38607	19.0	.3037	.3037	.01598	56	2
38608	17.6	3.0228	.3359	.01913	60	11
38609	19.5	6.7665	.4511	.02309	65	6
42205	18.8	1.8494	.1699	.01967	68	6
44605	18.3	1.1271	.3757	.02049	53	3
44606	17.7	2.5235	.3605	.02035	52	8
48405	19.0	.9701	.2425	.01276	55	5
50706	17.5	.4701	.2350	.01343	38	2
55905	18.4	5.7948	.3219	.01751	75	34
55906	19.2	7.9968	.3076	.01603	85	40
56105	17.7	5.7431	.3023	.01709	70	35
56207	17.7	10.9073	.4195	.02361	84	42
57307	16.3	4.7117	.2945	.01801	67	17
69705	17.4	3.7810	.2701	.01550	88	28
74508	19.0	.8172	.2724	.01434	50	4
81708	19.1	7.3993	.4933	.02578	86	20
88608	18.5	1.5355	.3839	.02075	69	4
92207	19.0	3.6926	.3357	.01767	73	15
92505	17.3	2.6615	.2957	.01706	68	12
95510	19.9	2.8356	.3544	.01783	70	8
Average	18.4	3.7758	.3383	.01862	64.1	13.7

SIZE OF HEAD, 20 TO 24 KERNELS.

17305	22.9	3.6302	0.4538	0.01984	61	12
17408	23.7	9.2038	.4383	.01852	73	24
17507	21.5	.7720	.3860	.01795	78	4
20705	21.8	1.8517	.3703	.01698	55	6
20706	23.3	3.3138	.4734	.02033	61	7
20707	21.1	9.9070	.4718	.02282	75	22
20709	23.5	5.3229	.4839	.02063	67	13
21207	23.6	2.3066	.4613	.01955	60	6
21212	21.0	1.7216	.4304	.02049	50	5
21306	22.6	4.1516	.4152	.01837	60	11
21707	23.3	12.3685	.4947	.02125	90	24
21708	20.5	9.2850	.4887	.02381	85	26
21809	20.9	8.0214	.4011	.01919	84	25
21811	21.0	11.9114	.4412	.02101	87	29
21812	22.9	14.8139	.3445	.01507	90	54
21907	22.6	2.9248	.4178	.01851	82	8
22205	23.6	2.6965	.2247	.00953	80	54
26106	22.5	2.0737	.5184	.02304	60	9
26806	21.7	2.7255	.3894	.01793	56	12
26807	21.8	17.2324	.5222	.02390	76	40
27207	20.7	3.3266	.4158	.02004	75	9
27307	23.8	3.0850	.4407	.01847	80	10
27505	21.6	12.0399	.4815	.02183	84	38
28805	21.7	2.1851	.5463	.02512	65	6
33105	22.0	2.5601	.4267	.01939	65	12
33405	23.4	8.1268	.4515	.01930	68	20
33407	21.8	7.0889	.5063	.02271	67	18
33906	23.8	2.2862	.4572	.01921	67	9
38606	22.3	8.4605	.4700	.02110	71	24
38706	21.5	7.2545	.4267	.01988	75	30
40405	23.0	.6316	.3158	.01373	54	3
43505	23.2	1.4464	.3616	.01555	45	3
45605	20.3	.7081	.2360	.01161	55	6
45705	22.0	.7532	.3766	.01712	58	6
48106	21.0	11.6655	.4023	.01919	79	39
48305	23.6	12.0278	.6014	.02543	81	28
48406	22.6	3.2964	.2997	.01324	68	13
48507	23.3	1.6036	.5345	.02296	63	7

27889—No. 78—05——8

TABLE 35.—*Relation of size of head to yield, height, and tillering of plant*—Continued.

SIZE OF HEAD, 20 TO 24 KERNELS—Continued.

Record number.	Size of head.	Yield per plant (grams).	Yield per head (grams).	Weight of average kernel (grams).	Height (cm.).	Tillering.
48806	21.0	9.8346	0.3782	0.01798	78	12
55205	20.0	.6893	.3446	.01723	56	6
55606	22.9	11.0930	.5042	.02205	92	24
55907	21.4	19.3966	.5542	.02590	95	42
55908	23.4	12.2210	.5092	.02175	95	40
55909	21.5	9.2120	.6580	.03050	85	31
56205	23.8	6.5232	.4659	.01959	82	29
56206	20.4	9.3093	.3724	.01829	86	42
56208	22.5	13.5720	.5429	.02356	88	51
56209	21.1	15.8086	.3513	.01664	90	67
57005	22.0	1.5364	.3841	.01746	73	7
57105	23.9	3.7263	.2192	.00916	85	40
57305	22.8	8.5777	.3899	.01666	78	30
57306	21.7	7.9772	.3989	.01838	80	23
57308	21.4	9.8378	.3644	.01705	80	40
57506	22.5	2.7616	.3452	.01534	72	18
57507	23.9	6.9861	.4657	.01946	78	26
57508	22.3	12.0728	.7102	.03177	85	22
63105	22.5	1.5452	.3883	.01717	68	8
63106	23.6	3.3006	.4715	.02001	77	9
63107	21.9	9.3120	.4901	.02233	80	25
72605	21.7	1.1166	.3722	.01718	52	3
72705	21.9	9.1522	.5384	.02191	68	20
74305	21.6	4.4222	.4422	.02047	60	11
74507	20.5	9.2130	.3839	.01869	70	27
74605	21.0	7.1181	.3746	.01784	69	27
74606	23.2	9.6451	.4822	.02079	75	24
76205	21.7	8.4407	.3670	.01695	70	26
81405	21.8	4.5737	.4158	.01862	70	11
81705	21.1	9.7922	.4451	.02106	82	27
81706	21.2	15.3928	.4527	.02132	90	40
81707	23.8	18.3614	.5564	.02336	96	53
81709	20.5	16.4692	.4451	.02175	90	45
84405	23.8	8.7448	.4858	.02043	75	19
88607	23.4	5.1584	.5158	.02205	73	15
91905	22.0	3.4436	.3826	.01739	72	12
91906	22.2	3.5486	.3943	.01774	74	11
92206	23.0	1.1074	.5537	.02407	66	3
92305	22.9	2.3859	.3408	.01491	65	11
92306	23.1	6.0091	.4006	.01732	75	19
92506	22.9	3.8709	.3871	.01690	77	16
92507	22.0	9.6779	.4208	.01916	82	29
Average.	22.2	6.8466	.4355	.01953	73.8	21.4

SIZE OF HEAD, 24 TO 28 KERNELS.

Record number.	Size of head.	Yield per plant (grams).	Yield per head (grams).	Weight of average kernel (grams).	Height (cm.).	Tillering.
17306	24.3	3.9968	0.3997	0.01645	66	12
17405	25.1	15.6996	.5414	.02127	72	34
17409	24.3	14.8957	.4514	.01857	85	39
20710	25.5	17.1115	.5032	.01974	77	39
21206	24.8	2.8564	.4761	.01917	62	6
21308	25.3	5.8080	.4149	.01641	54	14
21706	26.9	19.3318	.6444	.02390	88	38
21709	25.8	7.7296	.5521	.02141	85	23
21711	24.2	17.1820	.4773	.01968	85	51
21806	24.9	14.2450	.5935	.02378	91	32
21808	25.7	19.7446	.4388	.01708	96	57
21810	26.0	1.0304	.5152	.01982	55	4
21913	27.3	10.1925	.5662	.02072	84	27
22210	27.1	6.0173	.5470	.02019	78	31
26808	24.7	3.8811	.4312	.01748	64	11
26905	25.1	6.4102	.4931	.01966	66	15
26908	24.0	3.9797	.4974	.02073	62	9
27205	26.2	16.4061	.4825	.01841	87	57
27305	24.3	5.5666	.5061	.02085	80	22
27506	24.7	10.0005	.5556	.02252	85	23
27507	25.0	1.3746	.4582	.01833	50	4
27508	27.9	5.5324	.6137	.02287	78	19
32608	27.5	1.0183	.5091	.01851	50	2
33107	24.5	6.1026	.4694	.01919	73	29
33305	25.0	3.1346	.5224	.02090	53	7
33406	25.7	4.6045	.4186	.01627	72	16
33408	25.7	1.1132	.3711	.01446	56	4

TABLE 35.—*Relation of size of head to yield, height, and tillering of plant*—Continued.

SIZE OF HEAD, 24 TO 28 KERNELS—Continued.

Record number.	Size of head.	Yield per plant (grams).	Yield per head (grams).	Weight of average kernel (grams).	Height (cm.).	Tillering.
33605	27.4	7.0596	0.6418	0.02345	65	14
33606	27.3	8.1890	.5489	.02144	72	17
33607	27.2	2.8903	.5781	.02125	58	6
33905	26.7	11.1476	.5867	.02194	77	23
34207	26.6	13.5556	.5894	.02219	77	22
37705	25.6	8.0905	.4495	.01972	60	22
39507	27.8	1.8862	.4715	.01699	59	4
45606	24.4	4.0358	.4484	.01834	59	13
48306	26.2	2.6571	.4428	.01692	58	7
48407	26.6	11.2890	.4181	.01572	82	53
48409	26.2	6.4302	.5358	.02048	74	19
48505	27.4	1.9154	.3831	.01398	70	7
48508	27.4	11.2008	.5091	.01858	80	36
55506	27.1	17.8506	.5578	.02062	95	58
56107	24.9	14.4556	.3023	.01658	90	49
57509	27.8	10.6261	.4830	.01739	84	37
57606	26.4	3.0790	.6158	.02333	78	8
57607	27.3	16.4433	.6090	.02234	87	48
57608	24.3	8.6189	.4788	.01968	83	38
58206	24.7	1.3961	.2327	.00943	75	29
63506	25.5	2.3986	.3998	.01568	64	7
65305	26.0	1.8018	.6006	.02310	65	10
65306	25.9	9.8298	.4681	.01807	75	28
65308	26.5	11.7066	.5321	.02008	77	35
66008	24.9	3.1555	.4505	.01814	76	8
69505	25.5	4.7116	.4712	.01847	66	13
69805	27.5	2.4420	.6105	.02220	62	7
69806	27.9	12.0136	.6007	.02153	75	28
72606	27.1	9.3629	.4681	.01724	82	26
72607	26.9	3.4442	.4920	.01832	74	8
72905	27.8	2.6462	.4410	.01585	59	5
74607	25.8	8.3406	.4390	.01699	76	31
80305	25.1	15.7835	.5442	.02165	70	33
81406	24.0	1.2391	.4130	.01721	55	3
81710	24.7	9.1411	.5713	.02308	90	24
84906	25.5	7.5438	.5029	.01975	65	16
85205	26.7	3.4766	.4386	.01625	65	11
86105	25.4	3.0282	.3785	.01495	68	4
86106	27.2	7.6241	.4765	.01749	76	25
88606	25.3	9.9456	.5234	.02068	85	23
88609	24.7	9.8719	.5196	.02100	74	26
88905	26.6	5.3069	.4824	.01811	82	17
92205	26.5	5.2616	.4047	.01525	72	18
92405	26.7	3.4356	.4294	.01605	78	10
92407	26.5	.8983	.4491	.01695	68	2
92907	24.3	4.4673	.4964	.02040	84	10
94206	25.1	7.5006	.4688	.01866	76	19
94208	24.8	3.7828	.2909	.01175	71	19
94407	26.2	6.7664	.4229	.01615	82	23
94907	27.2	12.1918	.5301	.01948	85	23
94908	25.0	2.3678	.4736	.01894	73	9
94909	24.2	3.6977	.2631	.01696	72	9
95506	25.9	11.0548	.4806	.01852	86	25
95507	26.0	12.1592	.5527	.02029	90	22
95508	25.5	14.4617	.4987	.01954	97	31
95705	26.5	10.3426	.4309	.01626	80	31
95707	26.0	.7577	.3788	.01457	67	4
Average.	25.9	7.5207	.4848	.01874	73.8	21.2

SIZE OF HEAD, 28 TO 32 KERNELS.

17505	29.0	0.3885	0.3885	0.01340	46	7
17506	31.0	2.2881	.7627	.02460	55	6
20805	31.7	14.6942	.6679	.02157	85	30
21208	28.7	5.1594	.5159	.01798	63	11
21209	29.7	1.4484	.4828	.01627	51	6
21210	29.6	3.9143	.4893	.01577	59	8
21805	29.3	20.9290	.4983	.01699	91	48
21905	28.2	14.3111	.5111	.01809	92	62
21906	31.4	10.4800	.8062	.02563	88	27
21908	28.8	3.5574	.5929	.02056	92	9
21909	30.9	12.1819	.7166	.02317	86	29
21911	29.5	8.4593	.6597	.02209	90	23

TABLE 35.—*Relation of size of head to yield, height, and tillering of plant*—Continued.

SIZE OF HEAD, 28 TO 32 KERNELS—Continued.

Record number.	Size of head.	Yield per plant (grams).	Yield per head (grams).	Weight of average kernel (grams).	Height (cm.).	Tillering.
22206	29.2	2.5712	0.5142	0.01720	70	9
22211	28.0	11.5675	.5784	.02062	88	59
26107	28.8	2.0390	.4078	.01416	67	6
27005	28.9	16.4120	.5471	.01895	77	40
27206	28.8	19.1854	.7106	.02469	90	49
27306	28.5	13.3011	.5542	.01945	88	48
27308	31.7	4.5123	.5640	.01777	88	11
27509	30.4	5.3615	.6702	.02206	73	9
32206	28.2	10.4036	.5779	.02052	71	26
32605	28.1	5.2268	.6533	.02323	71	9
32606	31.3	2.0162	.6721	.02145	69	3
34205	30.9	9.1498	.6100	.01972	78	19
34208	31.2	2.9886	.5977	.01916	66	5
37305	30.9	6.1394	.6139	.01987	58	12
38505	29.6	12.1088	.6373	.02252	70	21
38506	28.3	1.6799	.5600	.01975	54	3
38605	30.5	1.2124	.6062	.01987	55	2
39405	31.9	9.3541	.6681	.02093	74	18
39606	31.4	4.6383	.4217	.01341	64	18
40305	29.8	3.6003	.6000	.02011	62	6
44505	30.9	5.9990	.5453	.01764	69	25
45005	29.4	3.2340	.4042	.01376	66	9
45805	31.0	1.5298	.3824	.01234	48	4
46107	31.9	8.3935	.5595	.01756	79	27
50905	31.6	2.3982	.3426	.01085	68	10
50906	28.5	1.7280	.4320	.01516	58	5
55005	30.2	7.9684	.6129	.02028	75	19
55006	30.1	7.1852	.4790	.01593	80	19
55007	29.5	2.1571	.5393	.01828	65	7
55206	30.4	11.3592	.5978	.01965	82	27
55306	30.6	4.1323	.5903	.01931	77	17
55307	31.1	5.6864	.5169	.01663	80	19
55507	31.5	9.8228	.6139	.01949	95	28
56106	28.0	12.0161	.5224	.01866	90	33
57006	30.5	10.1836	.4427	.01453	88	41
57407	31.8	14.9992	.6250	.01968	92	41
58207	30.7	4.2207	.4221	.01375	75	18
58505	31.1	7.4516	.6210	.02730	80	18
58806	31.7	1.9469	.6489	.02049	65	7
59606	29.8	9.7084	.5109	.01712	80	37
63505	29.7	4.0230	.5747	.01934	66	8
65307	31.1	7.0051	.5838	.01878	74	17
66005	30.8	7.6690	.6391	.02073	75	22
69506	30.1	13.5696	.6168	.02047	73	24
71905	29.3	28.2136	.6561	.02239	80	46
72406	30.7	8.2929	.5923	.01929	70	15
72706	29.5	14.6802	.7340	.02484	80	27
72707	28.1	4.5806	.5726	.02036	72	8
76206	29.8	5.4411	.3627	.01217	73	30
88906	30.3	9.9034	.5502	.01814	80	21
92408	29.6	3.7820	.5403	.01827	81	7
92908	31.2	3.2388	.5398	.01732	76	7
94205	31.3	1.2117	.4039	.01893	55	6
94207	29.9	13.7057	.5711	.01909	83	31
94209	31.7	3.6006	.6001	.01895	75	7
94406	28.9	10.5556	.5556	.01923	82	22
94605	28.0	.7319	.3659	.01307	68	7
94606	29.9	11.8435	.5383	.07544	84	23
94905	31.8	4.4423	.4936	.01553	75	11
94906	29.8	12.3862	.5385	.01808	91	24
95706	29.7	5.1629	.5736	.01934	82	9
Average.	30.1	7.4992	.5598	.01958	74.5	19.4

TABLE 35.—*Relation of size of head to yield, height, and tillering of plant*—Continued.

SIZE OF HEAD, 32 TO 36 KERNELS.

Record number.	Size of head.	Yield per plant (grams).	Yield per head (grams).	Weight of average kernel (grams).	Height (cm.).	Tillering.
17307	34.5	3.1454	0.7863	0.02279	70	8
18905	34.3	1.4864	.4955	.01443	50	4
26105	32.7	1.8242	.4560	.01393	69	13
26907	34.0	1.8276	.6092	.01792	55	8
28806	34.2	14.4630	.7232	.02111	75	30
34405	34.5	4.1281	.6881	.01994	62	8
34606	35.0	6.1962	.7745	.02213	61	13
36905	33.4	5.0200	.6275	.01880	58	7
39205	32.2	21.5399	.6731	.02089	82	40
42405	33.0	1.4892	.7446	.02251	60	2
42905	33.5	1.2499	.6249	.01866	68	4
48506	32.7	9.4585	.5564	.01701	82	30
49505	33.5	1.2716	.6358	.01898	60	3
51005	34.5	15.5835	.6233	.01804	75	32
55008	33.7	17.4226	.6222	.01846	82	30
55305	33.4	2.5160	.5032	.01507	75	12
55308	33.1	9.5078	.7923	.02395	79	28
55605	33.3	10.9180	.7279	.02184	89	23
55607	34.5	2.3931	.5983	.01734	77	7
55608	33.5	22.5848	.9034	.02699	95	31
57007	33.6	3.3176	.6635	.01975	90	9
57406	33.7	2.4923	.6231	.01846	92	14
57408	35.0	12.2004	.7177	.02047	90	26
58805	35.1	23.1471	.7014	.01999	78	51
60605	35.0	.5952	.5952	.01701	57	4
69305	34.3	2.0430	.6810	.01984	70	7
72405	35.5	8.4415	1.4069	.03963	67	6
72708	33.2	9.0386	.7532	.02270	78	12
73308	34.7	14.2986	.7944	.02291	74	23
85206	34.2	4.9315	.4483	.01312	69	13
88605	34.5	1.6362	.8181	.02731	70	3
91305	34.5	3.0940	.7735	.02242	76	6
92208	35.3	6.6206	.6621	.01876	78	17
92406	34.5	8.2366	.7488	.02168	81	17
92409	35.0	5.7131	.6348	.01814	81	13
92905	35.2	2.7000	.5400	.01534	75	6
92909	33.1	10.1363	.6335	.01916	86	21
95509	34.5	2.9475	.7369	.02136	74	4
Average.	34.1	7.2530	.6868	.02023	73.9	15.4

SIZE OF HEAD, 36 KERNELS AND OVER.

Record number.	Size of head.	Yield per plant (grams).	Yield per head (grams).	Weight of average kernel (grams).	Height (cm.).	Tillering.
18906	65.0	0.9229	0.9229	0.01420	67	5
21813	43.2	4.0258	.8051	.01877	80	21
34206	40.5	1.5940	.7970	.01968	74	5
37707	38.6	3.3004	.6601	.01710	64	5
40205	38.8	3.6302	.7260	.01871	65	11
40505	42.5	4.1546	1.0386	.02444	60	4
43405	41.3	2.8000	.9333	.02258	64	3
46105	37.1	4.6146	.6592	.01775	73	8
48705	44.0	4.3615	.7269	.01652	80	7
48706	47.4	6.1986	.7748	.01635	78	12
55508	36.0	3.7407	.6222	.01732	73	12
57405	41.0	.8328	.8328	.02031	73	1
57805	38.6	4.8988	.6998	.01814	76	17
57905	36.8	2.4731	.4122	.01118	74	17
58705	58.7	2.5436	.6359	.01082	68	11
58905	42.5	2.3031	.5758	.01355	66	13
59605	38.2	7.1828	.7183	.01880	77	30
62805	37.0	1.3451	.4484	.01212	70	14
66006	52.3	6.0090	.8584	.01642	73	12
72806	36.7	2.0970	.6990	.01906	62	5
73306	37.6	8.5373	.7761	.02062	78	20
81505	48.7	2.8327	.9442	.01940	78	7
84905	37.0	.7130	.7130	.01927	47	4
92906	36.2	2.8816	.5763	.01592	75	7
95505	37.0	.3146	.3146	.00850	79	3
Average.	42.1	3.3723	.7148	.01710	71.0	10.2

TABLE 36.—*Summary of relation of size of head to yield, height, and tillering of plant.*

Classification according to number of kernels on head.	Number of plants.	Average number of kernels on spike.	Yield per plant (grams).	Yield per head (gram).	Weight of average kernel (gram)	Height (cm.).	Tillering.
Below 16	18	13.3	1.3169	0.2654	0.02059	55.2	6.9
16 to 20	36	18.4	3.7758	.3383	.01862	64.1	13.7
20 to 24	80	22.2	6.8466	.4355	.01953	73.8	21.4
24 to 28	84	25.9	7.5207	.4848	.01874	73.8	21.2
28 to 32	73	30.1	7.4992	.5598	.01958	74.5	19.4
32 to 36	38	34.1	7.2530	.6868	.02023	73.9	15.4
More than 36	25	42.1	3.3723	.7148	.01710	71.0	10.2

TABLE 37.—*Relation of yield of plant to height and tillering, and to the yield per head.*

Classification according to yield per plant, in grams.	Number of plants.	Yield per plant (grams).	Height (cm.).	Tillering.	Yield per head (gram).
Below 1	31	0.6050	56.5	3.7	0.3553
1 to 2.5	67	1.7673	62.2	7.0	.4740
2.5 to 5	87	3.5526	69.1	11.6	.4917
5 to 10	93	7.6485	75.4	22.1	.5320
10 to 15	51	12.2862	84.4	32.3	.5592
15 to 20	20	17.1908	84.6	42.9	.5310
More than 20	5	23.2829	85.2	43.2	.6865

TABLE 38.—*Relation of yield per head to yield, height, and tillering of plant, and to weight of average kernel.*

Classification according to yield per head, in grams.	Number of plants.	Yield per head (gram).	Yield per plant (grams).	Height (cm.).	Tillering.	Weight of average kernel (gram).
Below 0.300	30	0.2484	1.6939	60.8	11.4	0.01586
0.300 to 0.400	62	.3567	3.7365	65.6	15.5	.01737
0.400 to 0.500	98	.4524	6.7326	72.8	19.9	.01847
0.500 to 0.600	78	.5477	9.5646	76.6	21.8	.02073
0.600 to 0.700	50	.6372	7.6214	74.3	17.3	.02056
0.700 to 0.800	25	.7456	4.4523	75.2	18.6	.02179
More than 0.800	12	.9229	5.7687	73.7	10.3	.02151

SUMMARY AND CONCLUSIONS.

As between wheat kernels of the same variety raised under similar conditions, those kernels having a high percentage of proteid material have a lower specific gravity, weigh slightly less, and occupy a smaller volume than kernels having a smaller percentage of proteids.

As between individual spikes and individual plants, the same relations obtain.

As between individual plants in different years, these relations do not hold.

The quality of high proteid content and its correlated properties may be due to immaturity in the kernel, or they may belong to the normal and fully ripened kernel.

As between kernels, spikes, and plants, those kernels of greater weight contain a larger weight of proteids—this in spite of the fact that they contain a lower percentage.

Plants bearing the largest number of kernels have kernels of more than medium but not the greatest weight, as do also plants producing the greatest weight of kernels. The same is true of plants producing the greatest weight of proteid matter and gluten.

Heavy seed wheat drilled at the rate of 1½ bushels per acre produced a much larger crop of seed the first year of the separation than did light seed drilled at the same rate, but by continuing the separation of the respective crops and selecting heavy seed from the crop grown from heavy seed, and light seed from the crop grown from light seed, the difference in yield in three or four years was small.

After the first year of separation the light seed produced a greater amount of proteids per acre than did the heavy seed.

A determination of the total or of the proteid nitrogen content in the kernels on one row of spikelets of wheat affords a fairly close estimate of the same constituents in the kernels on the other row of spikelets.

A determination of the total or of the proteid nitrogen content in the kernels on one-half of the spikes on a wheat plant will give a very good estimate of the same constituents in the kernels on the other spikes, provided there are at least an average number of spikes on the plant.

There may be quite a large variation in the proteid nitrogen content of different spikes on the same wheat plant.

Determinations of the proteid nitrogen content of 800 spikes of wheat of the same variety representing different plants showed a variation of from 1.12 to 4.95 per cent of proteid nitrogen, and 351 plants of the same variety the following year varied from 1.20 to 5.85 per cent.

The proportion of gluten to proteids in kernels of different wheat plants may vary considerably. A determination of proteid nitrogen is therefore not always a guide to the gluten content of the wheat. Selection for improvement should be based on the determination of gluten.

Wheat plants having kernels high in gluten contain a smaller proportion of other proteids than do plants of medium or low gluten content.

In wheat of the same variety, raised in the same field in the same year, the ratio of gliadin to glutenin was practically the same in plants of low, medium, and high proteid nitrogen content.

It may therefore be assumed that an increase in the gluten content of a given variety of wheat raised in the same region would carry with it a corresponding improvement in its value for bread making, although there might be fluctuations from year to year in the quality of the gluten.

The content of proteid nitrogen, the kernel weight, and the total proteid nitrogen production by the wheat plant are hereditary qualities.

There is a tendency for plants possessing any of these qualities in an extreme degree to produce progeny in which the same qualities approach more closely to the average, but certain exceptional plants may transmit the same or more extreme qualities.

The yield of grain per plant after a severe winter was decreased in proportion to the susceptibility of the plant to cold. The effect of the cold caused the plant to produce a less number of heads, or, in other words, to tiller less.

The early-maturing plants yielded the most grain, and those ripening later produced in each case less when grouped into ripening periods of four days, extending through more than three weeks' time.

The early-maturing plants produced grain of slightly lower nitrogen content than the later maturing plants, and the number of grams of proteid nitrogen in the average kernel was likewise less in the early-maturing plants.

Plants with heads of slightly more than medium size produced the largest yields of grain, and were taller than plants with either larger or smaller heads. Plants with heads of medium size, or slightly less, tillered most extensively.

The weight of the average kernel did not increase with the size of the head, nor did it decrease, except on the very largest heads.

The largest yielding plants were the tallest and tillered most.

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